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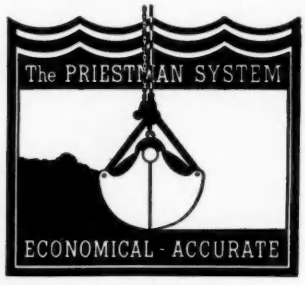

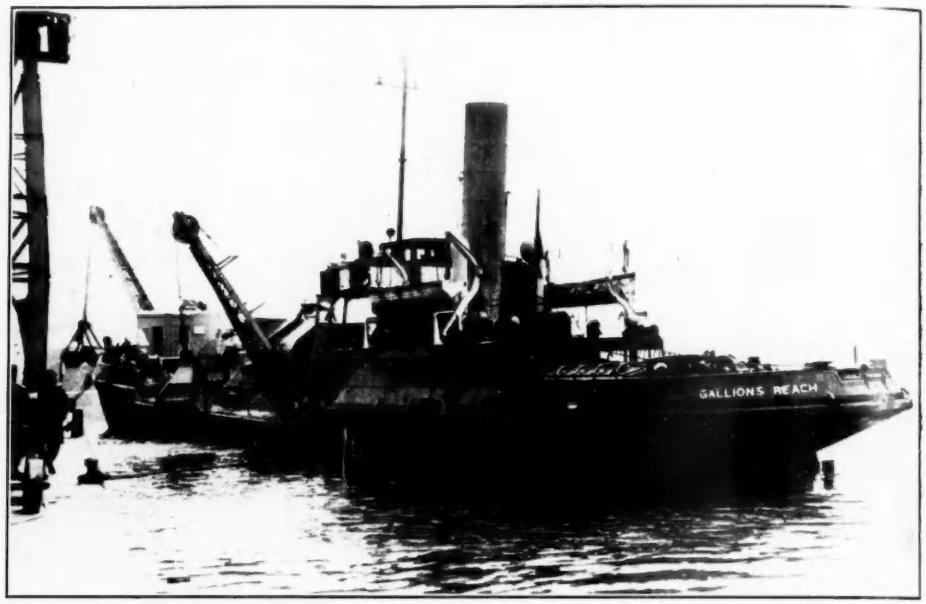

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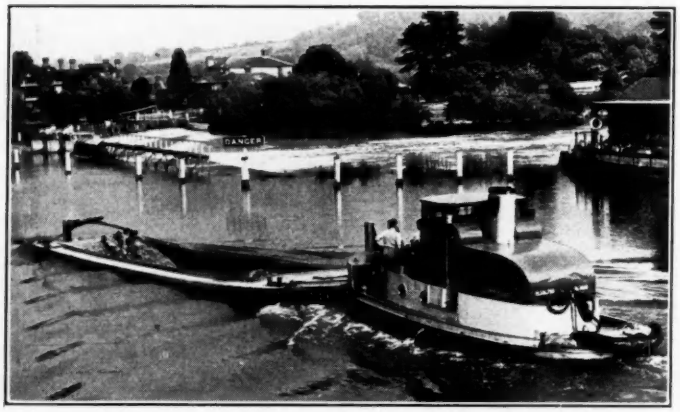

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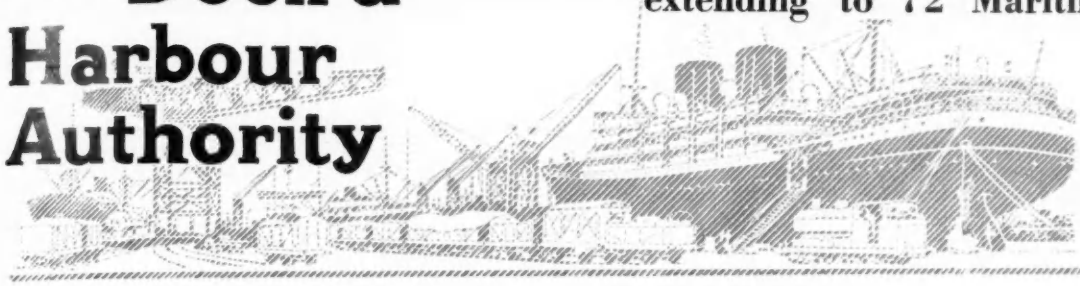


Editorial Comments

Large Dry Docks.

The second and final instalment of the article on No. 4 Dry Dock, Genoa, will be found on a following page. This deals with the final construction work at the site, the dock pumping arrangements and equipment.

Besides the unusual design of this dry dock, other features of interest will be apparent in this portion of the article, and no special reference is required. However, in respect of the hydraulically operated bilge blocks at Tilbury Dry Dock, mentioned in the text, it may be desirable to briefly describe them for the benefit of readers to whom they may be unfamiliar.

Each bilge block consists of a framed base of rolled steel joists, 22-ft. 6-in. long at 3-ft. 3-in. centres, carrying a heavy steel girder hinged at the inner end, the outer end being raised or lowered by a sliding carriage, propelled by a double acting hydraulic ram housed in the base frame. The carriage carries two rollers, which, travelling against the inclined underside of the outer end of the girder, give it the necessary vertical movement. The girder has a width of 3-ft. 4-in. to ensure coming in contact with at least one frame in a vessel, and is capped with soft wood 12-in. thick. Three positions of each bilge frame across the dock provide a range to cover all sizes of vessels.

The need for larger dry docks is a subject that has received considerable notice during recent years, and attention has been drawn in these columns and elsewhere to the growing obsolescence of the older dry docks of the world. In our view arbitrary increases in ship dimensions are, in the long run, likely to prove uneconomic to the community if due attention is not given to the embarrassing problems created for port and dock owners in providing adequate accommodation for exceptionally large vessels.

Ship Accommodation at Ports.

In view of the foregoing, the report on the above subject by the United States National Committee to the Permanent International Association of Navigation Congresses, is of undoubted interest. It is the first to be published, and a review of the Committee's recommendations in respect of American ports appears on page 201 of this issue. Readers will remember from the brief reference to the matter in our June issue, that similar reports are being prepared by all the major maritime countries.

The subject is one of vital importance to all concerned. There have been many complaints of lack of co-operation between shipbuilders and owners on the one hand, and port authorities and engineers on the other. It will be recalled that the creation and maintenance of adequate depths at seaports and their approaches was framed as a question for the London Congress (1923) of the P.I.A.N.C. However, that Congress was unable to formulate any conclusions, and had to be content with a resolution that the matter be placed on the agenda of the Brussels Conference (1935) and that representatives of shipowners and shipbuilders, port authorities and harbour engineers should jointly conduct a research concerning the dimensions to be adopted for vessels of the future and of port facilities to accommodate them. It was stated also that absence of such collaboration in the past had apparently hampered the national development of harbours and vessels.

Unfortunately, the Brussels Conference of 1935 produced no results of importance. The present American Report can therefore be regarded as encouraging, and should be welcomed as a positive contribution to a hitherto intractable problem.

It is particularly noticeable, however, that it seems to be regarded as axiomatic that adequate depths of entrance channels and berths at United States ports must be provided for vessels of whatever dimensions shipowners may decide to build in their own economic interests.

Due primarily to geographical and other favourable conditions, such as the absence of enclosed docks and large tidal ranges, this may be relatively easy of accomplishment in the United States. It must also be remembered that in many American ports, piers are actually owned by shipping companies or are leased to them, and the provision and maintenance of sea and river approaches, etc. are the responsibility of the State.

At many ports elsewhere in the world, however, where conditions similar to the above do not exist, i.e., those situated in tidal rivers and estuaries, the conclusions reached by the American Committee may be impracticable and physically impossible. It will be interesting therefore to study the reports of the other maritime countries when they are made public.

While the creation and maintenance of depths of ports and their approaches is perhaps of the greatest importance, we consider that the opportunity should also have been taken to study the broader question of ship sizes in general, for one dimension cannot be properly divorced from the others. It is possible that those port authorities, to whom beam and length of vessels are also of great importance, will have something to say when making their recommendations to the P.I.A.N.C., as the appreciable increase in the dimensions of ships during recent years, is having serious repercusssions on existing port accommodation and facilities.

It is to be hoped that the reports of the other maritime countries will soon be available and that from the data obtained, the Permanent International Association of Navigation Congresses will be able to put forward clear cut and authoritative recommendations for an international approach to the whole problem which has wide physical and economic implications.

Oil Pollution Conference.

The International Conference on Oil Pollution of the Sea, reported elsewhere in this issue, was probably a greater success than even its organisers anticipated. Although unofficial, the meeting was of undoubted importance, due to the presence of Mr. Lennox-Boyd, Minister of Transport and Civil Aviation, Lord Hurcomb, a former secretary of that Ministry, Mr. Donald F. Anderson, chairman of the General Council of British Shipping, and Sir Douglas Ritchie, chairman of the executive committee of the Dock and Harbour Authorities' Association, for they lent a *cachet* to the proceedings which would otherwise have been lacking. Perhaps, not unexpectedly, it was from these speakers that the practical suggestions came.

Many of the delegates from the 25 countries represented were associated with nature societies and were concerned about the effects of oil pollution on bird and animal life. Dr. Lillie, indeed, gave a harrowing account of his experiences while acting as surgeon to one of the Antarctic whaling fleets. Mr. Anderson said few if any shipowners would feel complacent if they knew that failure to do something which they could do to prevent oil pollu-

Editorial Comments—continued

tion meant the destruction of sea birds, or indeed sea life in any form. He was speaking, of course, only for British shipowners, but there is no reason to suppose that those of other countries do not share his views.

The first suggestion of a constructive character came from Lord Hurcomb. He realised that the prevention of oil pollution is, indeed, a long-term problem, that remedies must be internationally applied, but that "weary years" of argument may easily defer the hoped-for solution unless somebody takes energetic action. He suggests that this "somebody" should be the Minister of Transport and that he should transform the Faulkner Committee into a Standing Committee, with instructions to report annually upon the rate of progress made in dealing with "this intolerable nuisance.' It is a suggestion worth consideration. The Faulkner Report has been generally accepted as a workmanlike and practical document. The Committee finished the task entrusted to it within ten months of its appointment. The shipping industry was strongly represented on it, as were dock and harbour authorities—the two groups which will be most actively concerned in implementing the recommendations if and when they secure legislative approval. The United Kingdom has already given a lead to the world; such a Standing Committee would be a powerful instrument to ensure that the subject was kept to the forefront. Machinery already exists to some extent, in the International Chamber of shipping, to check and record the "anti-pollution" movement. It may well be that a Government Standing Committee and a private enterprise counterpart could, between them, stimulate the adoption of proposals corresponding to those in the Faulkner Report by all the maritime countries of the world.

Obviously, an ordinance imposed by the United Kingdom Government under which our shipowners and ports would incur great expense in equipment on ships and on shore, would be of little avail if foreign vessels were able to continue, with impunity, to pump oily wastes and residues into the sea only a few miles beyond the limits of our territorial waters.

British oil companies, shipowners and dock and harbour authorities have already announced their willingness to accept their share of the burden of preventive measures. The statement of the Minister of Transport to the effect that the British Government was about to invite other maritime Governments to a conference to discuss the problem is therefore to be welcomed as an obvious step. Mr. Anderson, however, expressed fears that there would be delays if the matter had to be dealt with by I.M.C.O., should that body be brought into being, or by the involved machinery of the United Nations. He quoted the International Convention for the Safety of Life at Sea of 1948, as a notable example of Governments collaborating for a specific purpose, and urged that such a Convention should be convened to deal with oil pollution.

As matters stand at present, the Declaration of Aims unanimously adopted at the conclusion of the recent Conference does little more than set out statements which are largely non-controversial and of itself does not contribute anything to the solution of the oil pollution menace. The most that can be hoped is that it will, in the words of the chairman, Mr. James Callaghan, M.C., "stimulate the Government of the principal maritime nations to agree among themselves to take all measures that may be necessary to end the scourge of oil pollution of the seas and coasts of the world."

As we go to press we learn that the International Chamber of Shipping, at their meeting in London this week, unanimously decided that an international technical committee should be set up to examine the extent to which the recommendations contained in the report of the Ministry of Transport on the Prevention of Pollution of the Sea by Oil could be adopted by the shipowners of other nations. This Committee will be asked to study the question of "prohibited zones," the provision of shore facilities for the reception of oil residues, and other major matters dealt with in the Report, in anticipation of the international conference of maritime governments which the British Government proposes to convene.

Topical Notes

Progress of East African Harbour Works.

The East African Railways and Harbours Administration recently reported that work on the construction of three deep-water quays at Dar-es-Salaam is now a further four months behind an already delayed schedule. The first new berth will not be ready for use until the end of 1954 and the remaining two until 1956. The original contract date for the completion of all three berths was October, 1954. When it became obvious that the contractors were not adhering to their schedule, the Administration asked for all possible measures to be taken to complete at least one berth by October, 1954. The main reason for the delay, according to the consulting engineers and contractors, is the difficulty experienced in the initial stages in block setting and developing a technique of speedy block laying. Most of the dredging required to be done at Dar-es-Salaam has now been completed, a total of 395,000 cubic yards having been dredged from the harbour and channel areas.

In the meantime, the new berth for coaster vessels has proved to be an invaluable addition to port capacity. Remarkably large tonnages are being handled over the present lighterage quay and congestion avoided, but there is a limit to what can be done with existing facilities, and from the time of amalgamation the East African Railways and Harbours Administration has considered that some addition to port facilities at Dar-es-Salaam would be necessary by 1954 at the latest.

The work at Tanga which is being carried out under the direction of the Administration, and which is due for completion in the middle of 1954, is making good progress, although recent heavy rains at Tanga, bogging down the heavy machinery, have caused some delay which it will be difficult to recover.

At Mtwara remedial measures to the quay wall are nearly completed and the first berth, together with transit shed, should be available for public use in the near future. The second berth and shed will follow within a few months. It is hoped, therefore, to open the port and the Southern Province Railway to public traffic early in the new year.

I.M.C.O. Delegates Meet in London.

On the initiative of the United Kingdom, representatives of the fourteen governments which have adhered to the Convention for the establishment of an Intergovernmental Maritime Consultative Organisation, met in London last month to consider what measures they might take to hasten its formation. They had been invited by a recent resolution of the Economic and Social Council of the United Nations to consider the question. An observer from the United Nations also attended.

Fourteen governments, all of whom were represented, have adhered to the Convention for the establishment of I.M.C.O. drawn up by the United Nations Maritime Conference at Geneva in 1948. These are: Argentina, Australia, Belgium, Burma, Canada, the Dominican Republic, France, Greese, Haiti, the Republic of Ireland, Israel, the Netherlands, the United Kingdom and the United States. Adherences are required from seven more governments to bring the Convention into force.

The Governments represented were convinced that an organisation with the expert qualifications and continuity of I.M.C.O. will be able to solve intergovernmental shipping problems more effectively and with less expenditure of time and effort than other bodies or "ad hoc" meetings to which these matters would otherwise fall.

The governments represented, joined in expressing their concern at the delay in bringing I.M.C.O. into being and unanimously stated the view that this "consultative and advisory" organisation is urgently required as a United Nations specialised agency in the maritime field. They also noted that the Convention has been ratified by governments of countries which are widespread geographically and thus reflects a variety of interest among both users and providers of shipping. They therefore wholeheartedly commend the Convention to other eligible Governments.

No. 4 Dry Dock, Genoa

Interesting Features of Design and Construction

By R. R. MINIKIN.

(concluded from page 167)

First Sealing and Emptying of the Dock.

When the engineers were satisfied that all had been done to ensure the stability of the walls, including the efficient housing of the upper transverse strut beams between the transverse caisson units it was decided to seal the entrance with the floating gate. As already remarked, this was to be done slowly to give ample time for observation of weak spots, and to fill in with concrete the gaps in the intrados of the wall units (see Figs. 4 and 10).

Originally it was computed that four pumps having a combined capacity of 1,500 cubic metres per hour would serve the purpose: however it was found that they were not capable of drawing the gate keels sufficiently tight to the sill seating. The operation was therefore assisted by a suction dredger. To effect this a 50 cm. diameter hole was cut in the upper division plate above the deck of the hull of the gate, and flanged connections were bolted to the plate. On the dock side a suction pipe into the dock water was fitted, and on the external flange a pipe led to the pump inlet of the dredger. The expedient succeeded, and once the gate was sealed the original four pumps proved adequate for the task. The lowering of the dock water surface in relation to the level of the outside water suddenly caused a great infiltration of water which the pumps could not deal with. The number of pumps were therefore increased to a combined capacity of 2,500 cu. m. per hour.

As the pumping went on it involved eventually placing the maximum stress on the walls which did not yet have the support of the floor therefore a careful survey was made of the deformations. During construction of the walls provision had been made to place, in all positions where maximum stresses were to be expected, pairs of metal plates as measurement points for the deformation meter. These register points were at a distance of 50 centimetres from each other. Whether due to the slowness of the water level reduction, or whether it was dilatation by increase of temperature which acted in a contrary sense to the stresses (mostly compressive), that were presumed to be measured, the results of the survey evaporated any doubts about the stability of the structure. It did on the contrary confirm that the mathematical computation of the stresses and those derived from the photo-elastic tests were much higher than in reality. This may have been due to the intervention of several

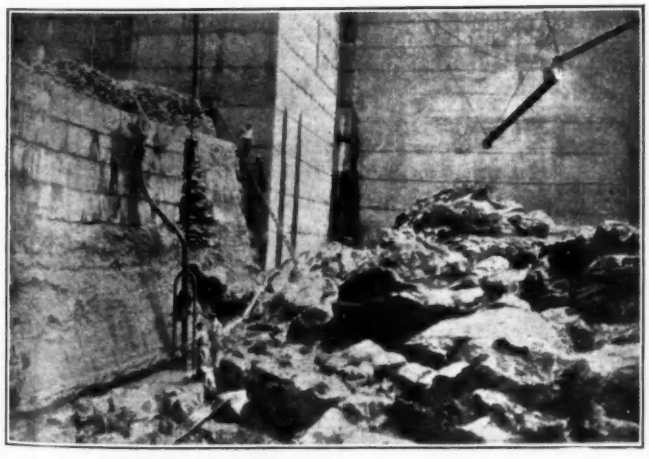
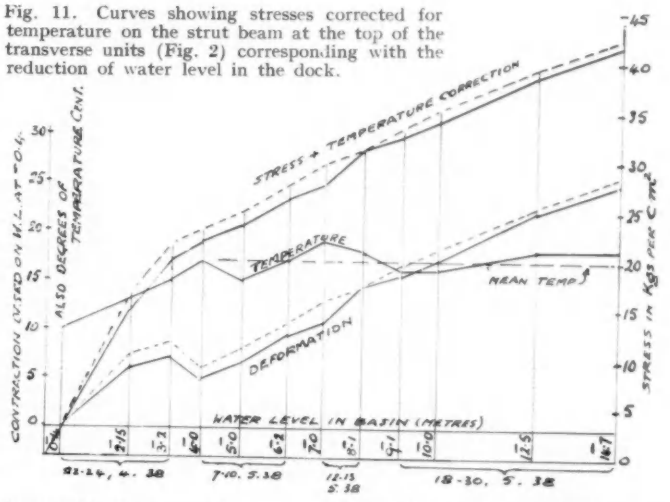


Fig. 10. The seabed rock exposed. To the left the concrete traverse between the bases of transverse units is seen. On its top is piled the loose stones gathered from rock bed, which was thoroughly cleaned. The prefabricated R.C. slabs of caissons joints are shown in centre of illustration. Workmen are busy in the search for leaks, whilst concrete is being poured to box in chambers on wall base.

Fig. 11. Curves showing stresses corrected for temperature on the strut beam at the top of the transverse units (Fig. 2) corresponding with the reduction of water level in the dock.



favourable factors which were not included in the calculations as, for instance, the cast *in-situ* concrete traverses on the rock bed between the bases of the counterforts.

The only notable feature that was registered was an effective contraction in the beam struts at the top of the counterforts. These struts were each designed to take a thrust of 550 tons. The data collected is given graphically in Fig. 11, which shows that taking into account the increase of temperature during the period of measurement the compression stress is 42 kgs. per sq. cm. (600 lbs. per sq. in.).

Stoppage of Leaks.

As the water level in the dock gradually became lower so did the volume of infiltration increase, slowing down the rate of exhaustion considerably. Eventually one was able to locate the situation of the leakages, most of them were about the bases of the joints of wall and counterfort. The flow of infiltration water under the considerable head of the outside water made it difficult to stop the leakages effectively in the open. It was therefore decided to treat the worst spots with the aid of compressed air and to deepen the foundations in the neighbourhood of the leakages. The dock was therefore pumped dry and drainage channels excavated in the rock to bring the water to convenient sumps in each of the eleven compartments formed on the rock bed by the traverses between the counterforts. All loose material found on the bed was then collected and cleared away (Fig. 10).

Shuttering was then erected around the areas where the leakages occurred. The rest of the cleaned floor, free from seepage or springs, was then filled in with concrete. About the trouble spots working chambers similar to Fig. 12 were erected complete with access shafts. They were keyed into the hacked concrete surfaces of the wall units' skins. Meanwhile the concrete of the dock floor and the added designed thickness of the walls was poured. When the height of the concrete was considered ample to withstand the pressure of the compressed air in the working chamber, the air locks were fitted to the access shafts.

The work of excavation into the rock under the units in the location of the leaks was then initiated. Under a low pressure of air just sufficient to reduce the water level in the chamber to a few inches above the drainage outlet which was then sealed quickly with rapid setting cement the operation of stopping the leak was commenced. Immediately the drainage was sealed, which in effect means that the air pressure had just overcome the infiltration, the

No. 4 Dry Dock, Genoa—(continued)

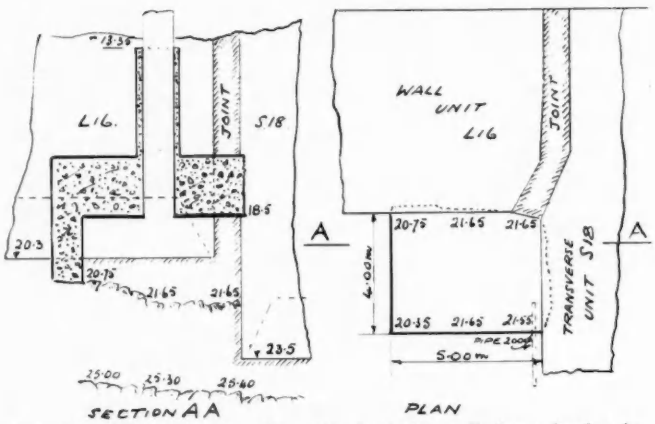


Fig. 12. Sketch showing the method of the preliminary boxing in of the area of wall leaks before laying the surrounding concrete of the dock floor.

were also others between them under the wall caissons. In all cases it was found that the cause was due to the bad quality of the rock: in several instances clay pockets occurred in what appeared to be solid rock. These pockets were sought out and eliminated. The photograph, Fig. 10 shows the jagged and accidented nature of the rock bed when cleared of loose material. In some places where jets of water showed a deep seated path through rock otherwise solid they were sealed by injecting cement grout at a pressure of 14 atmospheres. To effect this a steel tube was led into the trouble spot and then anchored by the concrete of the floor. It was found that the grout flowed more easily when mixed with shell flour. In such injections 1,370 tons of cement and 280 tons of shell flour were used.

In sum, all this work was successful as when the operation first began the infiltration was about 2,000 cubic metres per hour, but when completed it was reduced to 40 cubic metres per hour.

For the floor the mix of the concrete used was 560 lbs. of ordinary cement to one cubic meter to give a strength of 300 kgs. per sq. cm. (4,270 lbs. per sq. in.) in compression. To neutralise the free lime 50 kgs. of pozzolana were added per cubic metre of concrete. For the added thickness of the cast *in situ* portion of the walls rooted in the floor pozzolana cement was used of 450 kgs. per sq. cm.

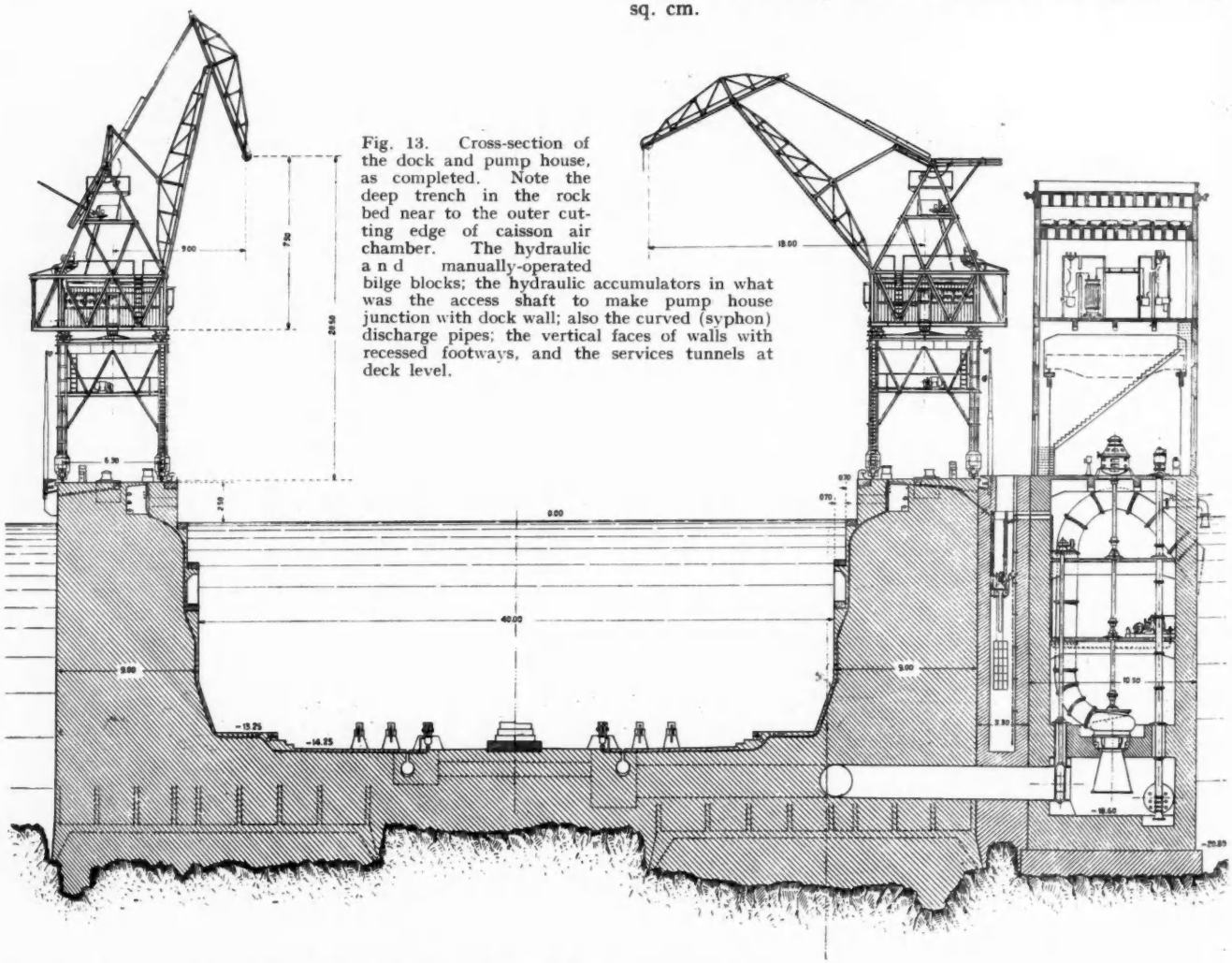


Fig. 13. Cross-section of the dock and pump house, as completed. Note the deep trench in the rock bed near to the outer cutting edge of caisson air chamber. The hydraulic and manually-operated bilge blocks; the hydraulic accumulators in what was the access shaft to make pump house junction with dock wall; also the curved (syphon) discharge pipes; the vertical faces of walls with recessed footways, and the services tunnels at deck level.

pressure was increased by degrees to equalise the outer head of water. In this connection one fact of particular note was that unhurried procedure produced the best results; not only in the search for the vulnerable places but also in the stoppage and the subsequent filling up of the working chamber with concrete and cement grout.

Although the worst leaks were encountered about the joints there

Unshipping Strut Beams.

As soon as the dock floor and walls were completed the problem arose of cutting out the reinforced concrete upper beam struts in a manner to avoid any sudden stress on the walls. To do this it was considered advisable to flood the dock first and thus relieve the walls of external loads. However, when the dock was flooded the

No. 4 Dry Dock, Genoa—(continued)

reduction of temperature and the release of the hydrostatic forces caused the struts to sever themselves from the walls, which remained still. Subsequent measurements made by means of the deformation meter showed that the opening of the walls was about one millimetre only at the tops. Such a small difference obviously shows that favourable compensations unforeseen and subsequently unknown and maybe indeterminate, must have operated.

The junction of the pump house with the dock wall was made in a similar manner to the wall joints with the difference that the gap was much larger and was pierced by galleries. There were three tunnels, two of 2.00 metres diameter, and one of 3.00 metres diameter linking up the pump sumps with the suction and flood galleries extending to the head, centre and heel of the dock floor. Divers were employed to place the reinforced con-

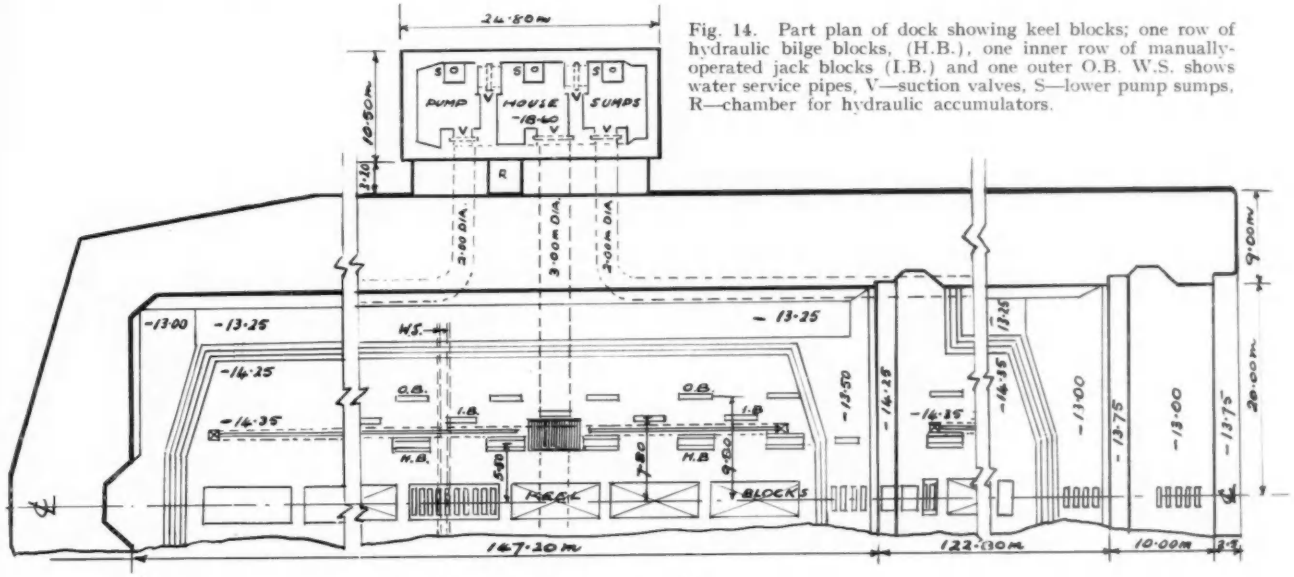


Fig. 14. Part plan of dock showing keel blocks; one row of hydraulic bilge blocks, (H.B.), one inner row of manually-operated jack blocks (I.B.) and one outer O.B. W.S. shows water service pipes, V—suction valves, S—lower pump sumps, R—chamber for hydraulic accumulators.

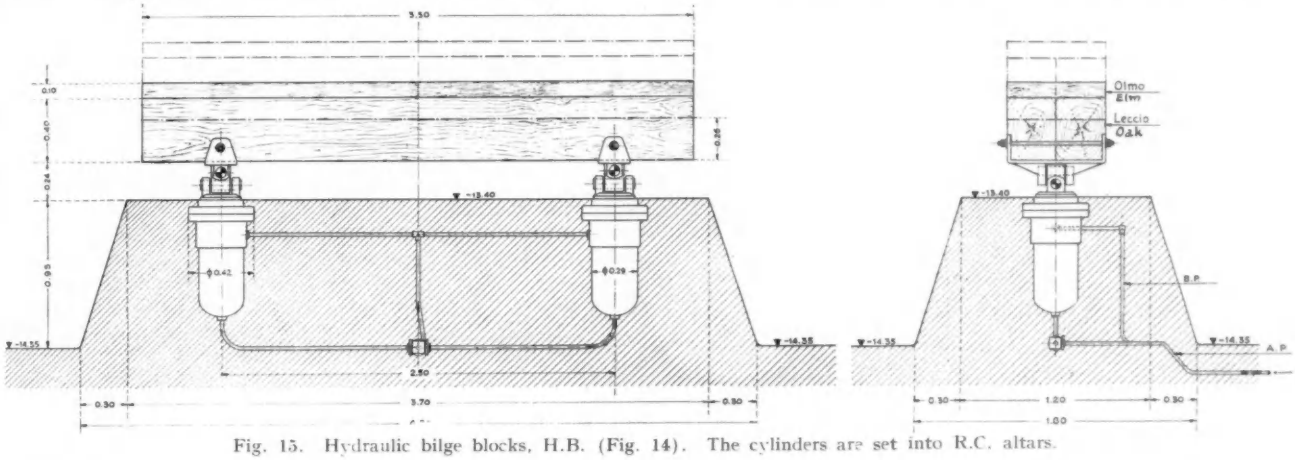


Fig. 15. Hydraulic bilge blocks, H.B. (Fig. 14). The cylinders are set into R.C. altars.

Pump House.

From the experience gained in the construction of the walls the original project of the pump house was modified. It was located on the south-west side of the dock wall in a structure 25 metres by 10.50 metres in plan, and was first of all fabricated as a cellular caisson of reinforced concrete in the basin which had already served for the wall caissons. The bottom was flat; there was no working chamber of compressed air, Fig. 13. In the preliminary stages it was floated out of the basin when the wall height was 14 metres, placed in a convenient spot where the walls were extended to a height of about 21 metres when it was taken to its final site and sunk in position.

The foundations took the form of levelling up the rock bed by means of a small mobile pontoon caisson such as used for the sill and traverses. Then four slabs of concrete each 12.0 metres by 4.0 metres in plan, were cast into the rock, spaced apart, with the long side normal to the dock walls and covering the area to be occupied by the base of the pump-house. The top surface of the slabs was at —20.80 metres level. The intervening spaces between the blocks were filled and levelled up with broken stone.

crete preliminary side junction slabs set in rolled steel sections secured to the sides of the walls and sealed up with rapid setting cement. The 3.30 metres gap was thus entirely concreted from the rock bed to the wall deck with the exception of the air access shaft. This shaft, after the completion of all work of linking up and sealing of the lower chamber, was left as shown at R in Fig. 14, to house the accumulators for the hydraulic plant used for the bilge blocks on the dock floor.

There were three vertical axis pumps with the rotors placed at −13.00 metres level and driven by three electric motors of 1,000 V, 450 r.p.m. 50 periods and with a total of 1,100 h.p. had a capacity of 16,500 cubic metres per hour. These were housed at deck level +2.60 metres. The plant is so designed as to empty and also fill the dock in case of need. This is achieved by arranging the discharge pipes 1.50 metres diameter as siphons rising to a height of +0.50 metres in a curved sweep and then on the downward sweep to the outlet at −3.60 metres each pipe increasing in section to 4 square metres at the end. At the summit of the curve on each pipe to avoid the return of the water by siphoning, with the machine idle, is a snifting valve which functions automatically under

No. 4 Dry Dock, Genoa—continued

hydraulic pressure, and can also be opened by hand when necessary. The pump rotor is situated at −13.85 metres to provide suction till water is lowered to the level of the floor canal. It is therefore nearly always flooded.

There are also three smaller pumps with vertical axes and triple helical rotors each having a capacity of 1,000 cubic metres per hour at 1,450 r.p.m. The suction inlets are at −18.90 metres and draw from the drainage sumps with bottom level of −19.30 metres. As with the larger pumps the discharge pipes are arranged to siphon with snifting valves at the highest points and submerged outlets. These snifting valves are automatic electrically operated besides having hand operating gear. A small well pump is placed at the −13.00 floor level to deal with infiltration and spill water collected in the floor drains.

There are six gate valves of 2.00 metres diameter of which four are in the pump house and two in the walls of the dock to control independently the two main suction galleries of 2.00 metres diameter to the head and heel of the dock.

The 3.00 m. diameter gate valve is also located in the pump house controlling the straight length of suction gallery to the gratings in the middle of the dock floor. All these valves are controlled hydraulically by oil at a pressure up to 80 atmospheres. There are also electric motors coupled up with the shafts of the valves with helical spurwheels (see Fig. 13). The lifting speed of each valve is about 12-in. per second. The movement of each valve is indicated on the panel in the control room through which all oil pipes pass, besides this all valves are equipped with tell-tale indicators.

When it becomes necessary to use the pump discharge as a suction for filling, that is to reverse its function, it was foreseen that the apparatus linking the snifting valve with the stopped pump would have to be provided with the necessary control to keep it closed during siphonage. The pump rotor was constructed to rotate in one direction only. The blocked pump and the closed snifter with the water in the lower sump drowning the mouth of the suction can then be caused to act in reverse. It was found of great practical advantage for a first filling of the dock to provide a convenient depth of water into which the filling water passing through the sluices in the entrance gate fell. The capacity obtained by this method was about 10,000 cubic metres per hour.

The top floor of the pump house holds the electric transformers, 12,000 v. to 1,000 v. and 12,000 v. to 500 v. comprising three transformers of 1,000 K.V.A. for the large pumps and a transformer of 350 K.V.A. for the smaller pumps and smaller transformers for lighting, etc.

The roof of the pump house was made 3 m. thick as air raid protection, making the overall height from rock bed to eaves 41.4 metres (134-ft.), a little over half (68-ft.) being above water level.

Bilge Blocks.

The dock floor supports for a vessel's hull arranged for this dock to dispense with the use of side shores registered a new departure in this type of adaptable construction. The high loads a large naval vessel imposes on the keel blocks, when in the dry resting only on its keel, renders it highly necessary to give immediate support to the hull by mobile side supports or bilge blocks. This timely and uniform support to the vessel's shell should come into action at the same time as the contact with the keel blocks is made to be efficient. The engineers concerned investigated many contrivances that had been devised for this purpose and were attracted by the system which had been installed at Tilbury, England. However, whilst the hydraulic action and adjustment was approved by them, they felt that the virtual point loading was a disadvantage, so that some other method which would give a distributed support was sought.

After preliminary trials in No. 3 dry dock the design shown in Fig. 15 was adopted: this comprised two hydraulic jacks joined by a common cap beam of sturdy proportions and elastic material which together were designed to give support over 3.60 metres in the length of the dock and over 0.60 metres width, that is, an area of 2.16 square metres. They were capable of a total supporting force of 120 tons which is equivalent to a pressure of 5.6 kgs. per square cm. (80 lbs. per sq. in.) on the skin of the vessel. The fore and aft cap bearers of timber baulks, the two main elements of holm oak being 40 x 30 cm. section, and the upper 10 x 60 cm. a single slab of elm, were held in steel crutches connected to the hydraulic pistons with universal joints, which allowed a closer adaptation to the sectional profiles of a vessel's hull over the length of the bearers.

The working pressure of the jacks is about 150 atmospheres and could be raised to 200 atmospheres. This is supplied by two pumps of triple cylinders and pistons absorbing 40 h.p. at a capacity of one litre per second. The compression liquid is an emulsion of fresh water with 10 per cent. glycerine. From the pumps the liquid is passed to an accumulator holding 10 litres which feed the distribution boxes placed along the walls of the dock. The plant is provided with two other pumps for lowering the jacks, at a pressure of 20 atmospheres, complete with their own accumulators and tubing system. There is also provision for the recuperation of the liquid.

There are 46 of these hydraulic jacks on each side of the keel blocks at a distance of 5.50 metres from the centre line of the dock.

Supports Operated by Hand.

Besides the above there are 56 other supports shown in section in two ranks on each side of the dock at a distance of 7.80 metres and 9.80 metres from the centre line respectively. These are operated by hand and consist of simple vertical pistons, or rams, operated by toothed gearing capable of greater extension than the hydraulic jacks. These are operated and bedded to the hull by divers immediately after the vessel has settled definitely on the keel and hydraulic blocks and whilst still under buoyant support.

Auxiliary Equipment.

Capstans. There are eight electric drum capstans with tractive force of 10 tons placed along the walls of the dock. Two capstans of 6T pull are placed, one on each side of the wall, near the central division gate. The motors are 30 h.p. and 20 h.p. respectively at 500 v, and have three controls only, ahead, reverse, and stop.

Cranes. There are two portal cranes, one on each wall, which can plumb over the centre line of the dock, of 30 tons maximum load. There are also two smaller cranes which have jibs, tracks, and dimensions allowing them to pass through the portals of the larger pair. Their capacity is 2.5/5 tons. It was eventually realised by the administration that the larger cranes could have been dispensed with and all of the heavy loads dealt with by the floating crane of 150 tons owned by the Consorzio, owing to the possibility of mooring alongside the walls. All cranes are supplied with current at 500 v., the larger cranes have motors for lifting of 50 h.p., 11 h.p. for rotation, 14 h.p. for luffing and 24 h.p. for movement on track.

The port of Genoa is now fully equipped to deal with repairs to vessels of the largest size (up to 60,000 tons) and of all types, liners, tankers, naval and cargo. There are five dry docks of which four are under the control of the industrial section of the Port Authority (Consorzio Autonomo del Porto di Genova) and are

	Length	Width on sill	Draught on sill
No. 1	557.75 feet	96.4 feet	27.8 feet
No. 2	688.9 feet	81.7 feet	26.2 feet
No. 3	853.0 feet	104.9 feet	35.1 feet
No. 4	918.6 feet	131.2 feet	41.6 feet
M.D.	272.3 feet	49.2 feet	20.0 feet

the latter is in the old port and is owned by the Municipality of Genoa. The monthly average of the vessels dealt with for important repairs in the year 1951 was 28 and an annual combined tonnage of 1,077,435, T. The peak month is usually January. The sum total of repairs and fitting out in 1951 carried out by the Consorzio industrial arm was 1,820,000 T of national and 805,000 T of foreign shipping.

The engineers for the contractors (Societa Italiana Lavori Maritimi) were Messrs. Luigi Peter and Filippo Bastianelli and for Port Authority the engineers were Messrs. Ariberto Albertazzi and Silvano Alleri.

Our grateful thanks are due to General F. Ruffini, the worthy President of the Consorzio Autonomo del Porto di Genova for his great kindness in giving facilities and in providing information for this article.

Rapid Ship Turn-Round

Value of Efficient Organisation

By E. S. TOOTH

Most discussions and enquiries into the quick discharge and loading of ships centre round the quality of the labour gangs employed. There are other important factors, however, which must be considered and the following is an attempt to put the matter in correct perspective.

It is of course not only since September 1939 that the quick turn-round of ships has been a matter of importance. The standpoint of shipping interests has always been that a ship ceases to be profit-earning during the time it is in port.

During the last war, speedy discharge and loading became a matter of national concern and the various Port Emergency Committees set up ships' output sub-committees whose specific task was to stimulate speedy work. Although in post-war years, speedy turn-round may no longer be a matter of life and death, it is still certainly one of national importance.

While the speed of turn-round of a vessel depends finally upon the working speeds of the ship and quay gangs allocated to it, these speeds vary over a wide range and depend upon many factors other than the ability and willingness of the labour employed.

Factors Controlling Discharge

Consider, for instance, the factors controlling the discharge of an ordinary general cargo vessel bringing say 7,000 tons of miscellaneous goods to London. A prompt and full start depends upon proper planning, which can only result from efficient organising by the Shipping Company, the Port Authority, the Cargo Superintendent and the Discharging Agent.

Details of the cargo—stowage plan and manifest—and of the ship's draft must precede the arrival of the ship, if possible by several days, and in these days of air mail and radio this presents little difficulty. With this information to hand, the ship's crane and shed space requirements can be assessed and, the dimensions of the vessel also being known, a suitable berth can be allocated to her. Without such knowledge, she may easily be placed at a berth where speed of discharging would be restricted, a fact which would immediately have a psychological effect upon the gangs, whose first interest is naturally the earning capacity of the job.

Assuming, however, that a suitable berth can be allocated, a prompt and satisfactory start largely depends upon good staff work by the Cargo Superintendent and particularly by the Discharging Agent. Representatives of these two bodies must consult as early as sufficient information is available. Of primary concern to the Discharging Agent are outlets for the cargo. It is important to know which consignments will be claimed for delivery direct to craft and which will have to be landed for (a) warehousing, (b) delivery to road vehicle, (c) delivery to railway wagon and (d) delivery to barges after sorting or some other operation has been performed on the quay. Most of this information is supplied to him by the Cargo Superintendent, whose most important duty at this stage is, indeed, to get it from the receivers quickly. Direct delivery from ship to road or rail vehicle is less often undertaken, since it is a much slower operation than landing on the quay and delivering through the transit shed.

The "Planner-in-Chief."

As he gathers his knowledge, the Discharging Agent becomes planner-in-chief. His task now is to arrange to employ the maximum number of gangs which circumstances permit and which the speediest discharge requires. To decide upon this, he must calculate how many gang-hours the cargo in each hold will take to discharge. By experience, he knows the various speeds at which the various goods can be handled and, knowing the tonnage of each commodity in each hold, his calculation is almost a matter of simple arithmetic. Almost, but not quite, for he must allow for (a) whether the goods are going ashore or to barge, (b) whether they will be handled by crane or ship's purchase (the approximate speed of which he will ascertain from the ship's chief officer), (c) their stowage in the hold—goods stowed in the square of the hatch will be faster working than those stowed in the wings; goods discharged from the lower hold will take longer than those stowed above them, because the hoist from the hold will be longer—and (d) the number of gangs he proposes to employ in each hold. Two gangs may work only $1\frac{3}{4}$ times as fast as one gang, because each may have less working space.

Having estimated the gang-hours necessary to empty each hold, he will begin to see the picture of the discharge more clearly. Consideration of a hypothetical example may assist us in understanding his problem. A five-hold vessel bringing a cargo of 7,000 tons of, say, thirty different commodities from the West Indies may work out something like this. No. 1 hold is estimated to have 52 gang-hours' work; No. 2 hold, 80 gang-hours; No. 3 hold, 42 gang-hours; No. 4 hold, 70 gang-hours; and No. 5 hold, 50 gang-hours. These times also allow for opening and closing the holds each day, for rigging gear (if necessary, for heavy lifts), for changing barges and for working from awkward stowages, such as deep tanks, refrigerated chambers and alleyways.

The Discharging Agent therefore knows that, if he is to get the vessel unloaded in the shortest possible time, he must put two gangs in No. 2 hold ("double-bank" it) from the beginning of discharge if possible and must get a second gang working in No. 4 hold almost as quickly. If only one gang can work in No. 3 hold—as is probable—then this hold or No. 2, with two gangs, will control the time which the whole ship will take, for it is reasonably certain that Nos. 1 and 5 holds can be double-banked for at least a day or two.

This planning is a vital factor in the speed of turn-round. No physical steps can be taken, however, until the ship arrives; but once she is at her berth the Discharging Agent can immediately go into action.

Among his first duties, i.e. before ordering gangs or even having cranes placed, is to consult with the chief officer. Having ascertained that the ship's gear complies with the requirements of the British Factory Acts (since the responsibility for safe working falls upon him) the Discharging Agent will seek any information which may help him in the actual discharge. Details of awkward stowages, of the condition of cargo and of the idiosyncrasies of the ship's gear or construction will assist him. This personal check-up is invaluable and, after having made it, he may wish to modify his initial programme. When this is settled (and it will be adjusted from day to day as work proceeds) his first action is to have the necessary ship's purchases rigged and the quay cranes placed. Care must be taken in these operations if the best results are to be obtained. Particularly must it be ensured that each crane satisfactorily plumbs hold and quay with the minimum slewing and luffing motions and, if the quay is narrow, leaves shed doors properly accessible. Cranes, by the way, are often preferred to ship's derricks because they can vary their plumb both in hold and on quay. If there is much cargo for barges, the ship will be berthed with a pontoon holding her off the quay, so that barges may be loaded on both her port and starboard sides. This will be another factor affecting the positioning of cranes. If the shed space position demands it, it may even be desirable, in the interests of quick discharge, to swing the ship in dock before bringing her to her berth.

Having made sure that H.M. Customs are in the picture, the Discharging Agent's next action is to arrange with his foremen the ordering of the necessary ship gangs and quay gangs and to ensure that adequate suitable gear will be at their disposal.

It is again emphasised that, if the vessel is to be turned round as speedily as possible, much attention must be paid to the preliminary work, for, upon the standard of its execution, outputs will to a large extent depend. If the gangs are not given facilities for speedy and uninterrupted work, discharge will certainly be unsatisfactory because as already stated, men working on piecework conditions are quick to see whether they have the opportunity to earn good wages.

Prompt starts and a full working day are matters over which the Discharging Agent has considerable control and, if achieved, reap their own output-reward—directly, by making the working period the proper length; indirectly, by making possible higher earnings. This aspect of the problem is material in all senses of the word.

However, given cranes, winches, adequate gear and equipment

Rapid Ship Turn-Round—continued

and outlets for the cargo, it is now up to the gangs—but still not **only** up to the gangs. " The Management," as the dock workers often call the controlling body, is still actively concerned. At the first labour call, each ship ganger is given a copy of the stowage plan of his hold, showing the outlets for all parcels so far claimed, and is told which purchase to use and what gear to employ—slings, boards, nets, hooks, baskets, grabs. Where the quay labour is employed by the same agent, the gangers are briefed in the same way. Each gang is directed to serve a specific ship gang, being allocated gear and mechanical appliances—fork-lift trucks, mobile cranes, electric platform trucks etc.—as the work demands and also is told the ultimate destination of each of the parcels which will come ashore.

To do this work properly, the Discharging Agent must keep his fingers on the pulse of every job, ship and quay. Delays and bottlenecks must be speedily eliminated. The breakdown of a crane or winch, a jammed hatch-beam, congestion of barges due, perhaps, to a strong wind, an error in the cargo plan, unexpectedly good or unexpectedly poor work by a gang—all such matter will affect the planned programme, as will a spell of bad weather. There are incidental matters, too, some very important, and some which only " oil the wheels." They include the provision of a canteen service at the morning and afternoon refreshment breaks, the working of overtime at the holds which require it, the provision of a ship-to-shore telephone and keeping an eye on the trim and the listing of the ship.

Heavy lifts require particular attention. If discharged by ship's derricks, there is the rigging and working of complicated gear; if handled by floating crane, the time at which the machine is required must be estimated correctly, sometimes days ahead, if there is to be no delay to the hold or loss of valuable crane time. An interesting point here is that hoisting a heavy lift is easier and safer than lowering it and a wise supervisor instructs that a test of the ship's lifting gear shall be made with the first lift handled, by first hoisting the load two or three feet and then lowering it back into stowage.

Competent Supervision Essential.

There is no doubt that organising ship discharge, besides being a technical job, is an interesting one—a fascinating one, in fact. It is also a man's job for, almost as important as organisation is high quality supervision, the need for which cannot be overstressed. The ship may be well constructed for speedy working, excellent purchases may be available, the type and condition of the cargo may be satisfactory and the gangs of good quality; but, without good supervision, many of these potential advantages will be lost.

Supervision is, in fact, a vital factor making for quick turn-round. No complex work such as ship discharge and loading ever runs itself satisfactorily and it is the Discharging Agent's duty not only to see that good labour has the best chance to obtain high outputs but that, should he unfortunately be allocated a proportion of unsatisfactory labour, this must not be permitted to thwart his carefully laid plans or to spoil the good work of willing men.

This, it may be thought, is easier said than done. Yet there are certain steps that can be taken to minimise the difficulties which must occur from time to time with labour, as with other factors in this complicated work. Firstly, the wise agent looks ahead. At some berths, he will have some say in the selection of gangs or even of individual men. Where this opportunity exists it should be taken. Secondly, and just as important, he must always be intimately enough in touch with the work (if necessary, through his foreman) to foresee difficulties before they arise. Forecasting a possible delay or anticipating a need for more men, for special gear, for a new piecework rate or for a special payment to compensate for abnormal working conditions should become almost a routine part of his duty. Once a job has stopped for any reason, it is often difficult to get it started again quickly; moreover, the question of payment for lost time is always difficult to settle, usually because the supervisor holds the opinion that in any case there need have been no stoppage. Delays, legitimate or otherwise, mean loss of opportunity to earn and reduced incentive means risk of new delays—a vicious circle, the best remedy for which is to foresee difficulties and prevent their materialisation.

Co-operation of Labour.

The majority of stevedores and dock labourers are good workmen, who appreciate efficiency. They will quietly support, too, action to prevent small groups of irresponsible men spoiling good jobs. The Union Official will often be of assistance here. If the agent puts his point that he does not intend to have the ship delayed by a few uncooperative men, he will normally get the Union's active support. In serious cases, there is opportunity to take disciplinary action through the National Dock Labour Board but it will usually be found that at a berth where "the management" is keen and efficient, the labour "following" consists of men willing to give a good day's work for good money and who will not support awkward men and malingerers.

Whilst discharge proceeds, therefore, each gang in each hold must be told what its particular job is and must be encouraged and assisted to do it as efficiently as possible. Care of cargo is no less important than speed; in fact, it often increases speeds of working. Bad handling can make " collecting loose " and " clearing up " in the hold a lengthy job. Proper supervision can eradicate bad handling.

Delays on the quay must be avoided whether due to temporary shed congestion, stoppages due to breakdowns of cranes and winches, delays due to non-arrival or slow changing of barges or to difficulty in identifying parcels in ship's hold—all these things are out of the gang's hands and matters for " the management." The Discharging Agent must be tenacious, not only in dealing with matters over which he has direct control but in his efforts to gain the maximum co-operation of other interested parties, particularly the Cargo Superintendent and the Lighterage Contractor.

The former must see that barges are ordered in good time; the latter, if he is to co-operate in quick turn-round, must get his craft to the vessel before his parcel rises from the hold. Taking a barge to a ship and thence to a specific hold and removing tarpaulins and hatch-covers can take a considerbly longer time if there is no enthusiasm for the job. The Discharging Agent certainly needs the co-operation of the lightermen.

The points made apply also to ship-loading. The placing of cranes to get the quickest operation, the prompt start and full working day, the selection of cargo for safe and speedy stowing in ship, speedy tendering and slinging at the ship's side, careful handling and, co-ordinating all these, high-quality supervision, are equally essential factors in quick turn-round.

Much has been written and said on the question of labour difficulties in the port industry and in ship work supervision is especially difficult. Efficient planning is therefore a big factor in smooth working, so indeed is the respect it induces in the dock workers. Confidence that speedy discharge and loading will result only from consistently good organisation and supervision is the only satisfactory working policy. The man in charge should have a wide experience of the work and should be supported by foremen with similar qualifications. He should have foresight and the right kind of personality. The one thing he should not lack is tenacity of purpose.

Tax Exemption Claimed by Eire Ports.

Officials of the harbour boards of Dublin, Cork, Limerick, Waterford, Drogheda, Sligo, Galway and Dundalk and Foynes met in the offices of the Dublin Port and Docks Board recently to discuss the question of income tax exemption for harbour authorities. The conference decided to request the Eire Revenue Commissioners to place their petition before the Minister for Finance. At present ports are liable to the full standard rate on revenue, in excess of expenditure on bare operation and maintenance. The Minister's attention will be drawn to the parallel between harbour authorities and local authorities. Both are taxing authorities, the former obtaining its income from dues on ships and goods, the latter from rateable property. Local authorities, however, are exempt. Another point to be raised is that development works lacking a 100 per cent. grant can only be carried out by borrowing, and authorities are faced with capital repayment which can only be made out of tax-borne revenue. Thus, should a harbour authority float a loan of £1,000,000 for development work, it is faced with a £600,000 tax liability on repayment.

Survey of Ship Accommodation at Ports

Depths to be Created in Seaports, Entrance Channels and Berths*

AT its annual meeting in 1951, the Permanent International Association of Navigation Congresses formed an International Committee to study the depths to be created in seaports and their entrances, as well as at their berths, to comply with tendencies of marine construction as regards dimensions and speed of large overseas vessels (liners, cargo ships, tankers, etc.). To assist in this study, National Committees have been set up, and the United States Committee published its report in April of this year. A brief reference to the Report was made in the June issue of this Journal. The importance of the subject and the value of the information and conclusions are such that a detailed review will undoubtedly be of great interest to those engaged in maritime affairs in this country where the reports of the National Committees of the British and other maritime countries are awaited with interest. The vessels considered are ocean-going and visit ports in all parts of the world so that the information contained in the report and the conclusions reached are international in their significance.

The American Committee have assembled statistics concerning foreign and coastwise tonnage, projected dimensions of entrance and inner channels and the number of berths with depths of 25-ft. and greater in eighteen representative large ports in the U.S.A. In considering channel depths they have studied the effects of tides and the nature of the channel bottom, the requirements of commerce and trends in ship building.

In considering the criteria that determine authorised channel and harbour depths, the Committee set out as a basic definition that the depths should be adequate to permit the largest commercial vessels in frequent use, or proposed frequent use in the harbour, to operate without undue hazard or delay. In addition the monetary benefits to be expected from improvements must be at least equal to the cost of carrying out and maintaining the work including interest, amortization etc. In evaluating these benefits the provision of a service at a cost which will attract new traffic must be considered.

Channel Depth Requirements

Channel depths have, in the past, tended to lag behind ship dimensions, resulting in sailings with under-capacity cargoes, partial lightening, waiting for tides and damages to vessels. The obviation of these disadvantages is an obvious factor to be considered when assessing grounds for improvements.

Depth requirements are considered in detail, the basic need being sufficient depth of water under the keel to permit safe and efficient operation of a ship under its own propulsion. The minimum clearance allowed has generally been two feet. The phenomenon of " squat " or " sinkage " must also be considered. This is the tendency of a vessel to settle down in the water as she moves through it. An allowance of 3.5 feet was made in the Delaware River channel where ships move at normal sea speeds, but in most harbours where reduced speeds are observed an additional depth of from 2 to 3 feet is required.

Allowances must also be made for trim where vessels are not loaded to an even keel, for loss in buoyancy in long channels where upstream reaches are less saline than the adjacent seas, and for pitching in entrance channels where wave action is considerable.

The effect of tides is of manifest importance. Their range varies widely over the long coast lines of the U.S.A. At Portland (Maine) it is 8.9 feet, on the New Jersey coast from 4.6 to 4.2 feet and at Key West (Florida) it is only 1.3 feet. At Seattle it is 11.3 feet. At ports where the tidal range is large it may be found uneconomical to provide sufficient depths at low water to accommodate the largest ships using the channel, even though this omission entails time being lost through waiting for tides.

The character of the channel bottom is a major factor in determining channel depths. Its most important effect is on the cost of artificial deepening and maintenance. An example quoted is the " New York and New Jersey Channels " Project where the deepening was in rock and where the authorised depth was fixed by economic considerations rather than the depth requirements of some vessels using the channels. The existence of rock has important bearing on maintenance. Where the surface of the rock stratum is at, or only slightly below, the authorised depth, maintenance dredging is expensive. A minimum difference in depth of 2 feet is advocated to facilitate maintenance. Channels are frequently not initially deepened to the full authorised depth. In rock channels the unit cost of removing a thin layer of rock is higher than that of removing a thicker layer and this must be borne in mind in these circumstances.

Ships must be able to lie at anchorage areas throughout all states of tide including the lowest, even though they may not be able to pass through the channels, hence these areas require depths based on a consideration of the lowest tides, with clearances to allow for protruding anchors.

In the United States main channels are generally provided and maintained by the Federal Government the authorised depths being based on navigational requirements as recommended by the Chief of Engineers, U.S. Army. The side channels to berths are the responsibility of the owners or lessees and the depths provided are based on commercial requirements.

Existing Depths

A considerable body of data relating to channel dimensions, principal items of commerce etc., is given in appendices to the Report. The relationship between the class of shipping and the depths provided is discussed. The largest passenger liners draw up to 39.5 feet and in New York entrance and harbour, channels of 45 feet and turning areas opposite piers of 48 feet depth have been provided. An additional depth of approximately 4 feet is available at high tide.

Smaller passenger liners drawing up to 32 feet 6 inches could be accommodated in most of the principal ports, but the bulk of the traffic is limited to New York, Los Angeles, San Francisco and Seattle. Similarly trans-oceanic passenger-cargo vessels with somewhat less draft are limited mainly to the Pacific ports and to New York, Boston, New Orleans and Mobile.

The depths in several United States harbours is dictated by bulk cargo vessels, and in particular tankers. The T-2 class of tankers have a loaded draft of 30-ft. The C-3, Liberty and Victory class cargo vessels, which form the bulk of the United States fleet all have drafts less than this. The importance of tankers is shown by the fact that their requirements have largely determined the authorised depths in Portland (Maine), 35-ft.; Savannah, 34-ft.; Lake Charles, 35-ft.; Port Arthur, 36-ft.; Houston, 36-ft.; Corpus Christi, 36-ft. and Portland (Oregon), 35-ft. etc. In 1951 the importation of crude oil from Sumatra to San Francisco was commenced and it is anticipated that the tankers used in this trade will have dead weights of 29,300 and 38,000 tons. At Mobile the present depth of 32 feet is considered inadequate and is being reviewed. The entrance channel to Baltimore, used by bulk ore carriers drawing 35-ft., is 39-ft. deep.

The depth in entrance channels is generally greater than that in the river channels mainly due to the pitch developed by vessels under the action of storm waves. At San Francisco where the authorised depth at the bar outside Golden Gate is 50-ft., a tanker drawing 29-ft. struck bottom in the Bay channel during a storm where the least known depth was 42.5-ft., though the tide gave an additional depth of 1.5-ft.

The depths at berths varies considerably and is related to the commodity and classes of ships handled. Reference is made to a publication entitled " Port Series " published jointly by the Corps

*A Review of the Report of the National Committee of the U.S.A., to the International Committee of the Permanent International Association of Navigation Congresses.

Survey of Ship Accommodation at Ports—continued

of Engineers and the U.S. Maritime Administration, wherein data on piers, wharves and docks are given.

Trends in Marine Construction

The "Queens" operating between Southampton, Cherbourg and New York have the deepest drafts (about 39-ft. 6-in.) of all passenger liners, and the "United States" is the fastest. It is unlikely that these will be exceeded in the forseeable future. Passenger-cargo liners showed little tendency to increase in size from the turn of the century up to World War II and ranged from 400 to 500 feet in length and 22 to 25 feet in draft. However, beginning in 1940, U.S. Maritime Administration vessels of from 420 to 492 feet have shown an increase in draft, all exceeding 26-ft. 6-in. with a maximum of 28-ft. 7-in.

At the close of the war, the U.S. Merchant Marine Fleet consisted principally of C-1 to C-3 classes and Victory and Liberty cargo ships. In 1951 the U.S. Maritime Administration commenced building the Mariner class with an overall length of 563-ft. 8-in. and 29-ft. 10⅜-in. draft compared with 27-ft. 8-in. and 28-ft. 6-in. for Liberty and Victory ships respectively. This is a significant development in cargo carriers and there is a possibility that cargo vessels 700-ft. long, by 90-ft. beam and 32 to 35 feet in draft may be constructed. Competitive trading conditions may tend to limit the size of this class due to the possibility, under highly competitive conditions, of vessels having to sail partially loaded.

A most significant and distinct trend is that towards larger tanker construction. During the period 1939-1945, 72 per cent. of the larger sized tankers were T-2 class with a full load salt water draft of 30-ft. In 1951 of 119 tankers built or under construction in the range 20,000 to 41,000 tons, ninety ranged between 24,000 and 31,000 tons with draft from 31-ft. 7-in. to 34-ft. 3-in.; eleven under construction had a dead weight of 31,000 tons or more. About 26 per cent. of tankers under construction in February 1953 have a deadweight of 30,000 tons or more. Two tankers are reported as currently on order with the following dimensions: length overall, 736-ft. 6-in.; beam, 102-ft. and draft 37-ft. 6-in.

The drafts of bulk ore carriers has not increased significantly in the last thirty years, though length, beam and speed have, this being due to lack of sufficient depths in the channels used.

Conclusions

The conclusions of the United States National Committee are of far-reaching importance and are based on a comprehensive and detailed investigation of data and trends. They are therefore quoted in full.

Trends in Marine Construction

(a) **Passenger Vessels.** It is unlikely that a draft of about 40-ft. for large passenger ships will be increased in the foreseeable future. The draft of intermediate size passenger ships is not likely to increase in sufficient amount to warrant serious concern.

(b) **Combination Passenger and Cargo Vessels.** The present trend in construction of combination passenger and cargo vessels is toward greater depth. A draft of 30-ft. appears at present to be a reasonable limit.

(c) **General Cargo Vessels.** The trend in construction of general cargo vessels is toward a draft of 30-ft., except for World War II C-4 ships. The World War II C-4 cargo vessels, when carrying general cargo, have a draft of about 30-ft. At present these ships are being used primarily as military auxiliaries. It may be expected in the future however, that some of these vessels will be used in private commerce either for general cargo or for the transportation of ore. As ore carriers, the draft would be about 34-ft. However there is no evidence to warrant the prediction that a substantial tonnage of this class of vessel will be converted to commercial use.

(d) **Tankers.** The trend in construction of tankers is toward larger and deeper draft vessels and increase in speed. An ever increasing number of large tankers are being built. At least seven tankers are being built or are on order having capacities in the range of 44,000 to 45,250 deadweight tons. The draft of two of these is reported to be 37-ft. 6-in. The economical limit of draft of tankers in the forseeable future will be determined by the depths of water provided in harbours and channels.

(e) **Bulk Ore Carriers.** The trend in construction of bulk ore carriers is toward greater capacity to be accomplished principally by increasing the length and breadth with such increase in draft as channel depths warrant. Drafts of 37-ft. 6-in. may be expected. As in the case of tankers, the economical limit of draft of ore carriers in the forseeable future will be determined by the depths of water provided in harbours and channels.

(f) **Bulk Cargo Vessels in General.** The design of large bulk cargo vessels is influenced by the depths available in harbours and channels. It is technically and economically sound to construct super-tankers and super-ore carriers. The cheapest way to gain additional capacity from the ship point of view is to increase the smallest dimension, namely the draft. It is the view of this Committee that if there were no limitations in depths of channel, the draft of many of the super-bulk-cargo vessels now under construction would have been designed to be in excess of 40-ft.

Conclusions Respecting Depths to be Created in Harbours or Main Inner Channels.

The Committee sets forth its conclusions regarding desirable depths to be provided in harbours and channels in each class of vessels discussed as follows:

(a) **Large Passenger Vessels.** A depth of 45-ft. provided in New York harbour for the largest existing liners is sufficient for present and prospective vessels of this class. A depth of 36-ft. for the harbour channel is considered adequate for the ports of call of other large vessels in this class.

(b) **Combination Passenger and Cargo Vessels.** A depth of 33-ft. for the harbour channel is considered adequate at this time for ports where the requirements of this class of vessels are the determining factor. The existing tendency toward increased size may make it desirable to provide 35-ft. of channel depth within the foreseeable future.

(c) **General Cargo Vessels.** The newest type of general cargo vessels (Mariner class) requires a depth of 35-ft. in the harbour and, as this type of vessel will become increasingly important as replacements for Victory and Liberty ships, at least this depth should be provided for this class of vessel.

(d) **Tankers.** A depth of about 35-ft. in salt water and 36-ft. in fresh water in harbours visited by tankers has been common in the past. There is however, a present need for increasing these depths in some seaports. Tankers used principally for the transportation of crude oil are increasing in size with a draft up to about 37-ft. 6-in. It is concluded that at least a 40-ft. depth of water is required for this type vessel.

(e) **Bulk Ore Carriers.** The Venore class bulk ore carrier (24,376 deadweight tons) requires about 39-ft. of water; a proposed carrier with a capacity of 40,000 tons of iron ore, which has been designed, will require about 40-ft. It is clear that the draft of the latter vessel has been influenced by the depth of water available in harbours. Without such limitation and under optimum conditions, the draft of this vessel would probably be such as to require about 48-ft. of water. It is concluded that at least a 40-ft. depth of water is required for this type of vessel.

A further conclusion regarding United States ports is drawn: except for ships where the requirements of the Navy govern the depth of the main harbour channel, the requirements of the bulk cargo ships such as the oil tankers and ore carriers will, in general, determine the desirable channel depth because of the tremendous and widespread commerce in these products.

Conclusions Respecting Depths to be Created in Entrance Channels

The Committee concludes that the depth to be provided in an entrance channel should be based on the conditions which obtain at each locality, giving consideration to: the nature and volume of traffic; the effect of exposure, currents, wave and wind action;

Survey of Ship Accommodation at Ports—continued

the nature of the bottom; the length of the channel to deep water and on the requirements of the shipping using or desiring to use the facility. The data accumulated from experience respecting the pitching of vessels when crossing the ocean bar or reef are a guide to a reasonable figure for the additional depth over the bar or reef. In a rock channel the hazard of striking bottom is ample reason for greater depth than in a soft bottom channel. In practice it has been found that, for channels through a gently sloping coastal plane of soft material as is usual on the Atlantic and Gulf Coasts of the United States, a depth of entrance channel two to five feet greater than that of the inner channel may be found necessary to permit safe transit under conditions of severe storm.

Conclusions Respecting Depths to be Created in Berths

The required depth at a berth will be fixed by the class of vessel expected to use the berth. The Committee concludes that the depth should be sufficient to enable a fully loaded ship to remain clear of the bottom under conditions of tide and trim reasonably to be expected. It should be sufficient to prevent contact between the ship and the bottom under conditions of abnormal low tide. The Committee concludes further that in general, the depth at a berth should be maintained at a plane which will assure a minimum of 1-ft. of water under the keel of the ship with an increase in depth up to about 5-ft. in the approaches to the pier to increase manœuvrability.

Tables and Appendices

The report includes the following tables: "Summary of Pertinent Data Concerning Large Tank Vessels of the World"; "World Tanker Construction as of February 1st 1953"; "Dimensions of Typical Large Passenger Vessels Indicating Trends in Construction"; "Dimensions of Typical Combination Passenger and Cargo Vessels Indicating Trends in Construction"; "Dimensions of Typical General Cargo Vessels Indicating Trends in Construction"; "Dimensions of Typical Oil Tankers Indicating Trends in Construction"; "Port Statistics—Tonnage, Channels, and Berths—1950."

The appendix includes additional information regarding important ports in the United States and contains extracts from letters received from authorities regarding trends in marine construction. These generally support the conclusions arrived at in the report. Attention is repeatedly drawn to the fact that the depths of new ships are limited by the existing available channel depths. The Chairman of the Board and President of the American Bureau of Shipping gives as his personal opinion "that no less than 50-ft. draft should be aimed at," and, he states that he is not sure "that this somewhat radical figure is deep enough."

Bulk Handling of Raw Sugar

Method Employed in Hawaiian Islands and California

Introduction.

Before describing the storage and transportation of raw cane sugar, as it has been developed by the Hawaiian cane sugar industry, it is desirable to describe briefly the nature of sugar production in Hawaii and its transportation to the mainland.

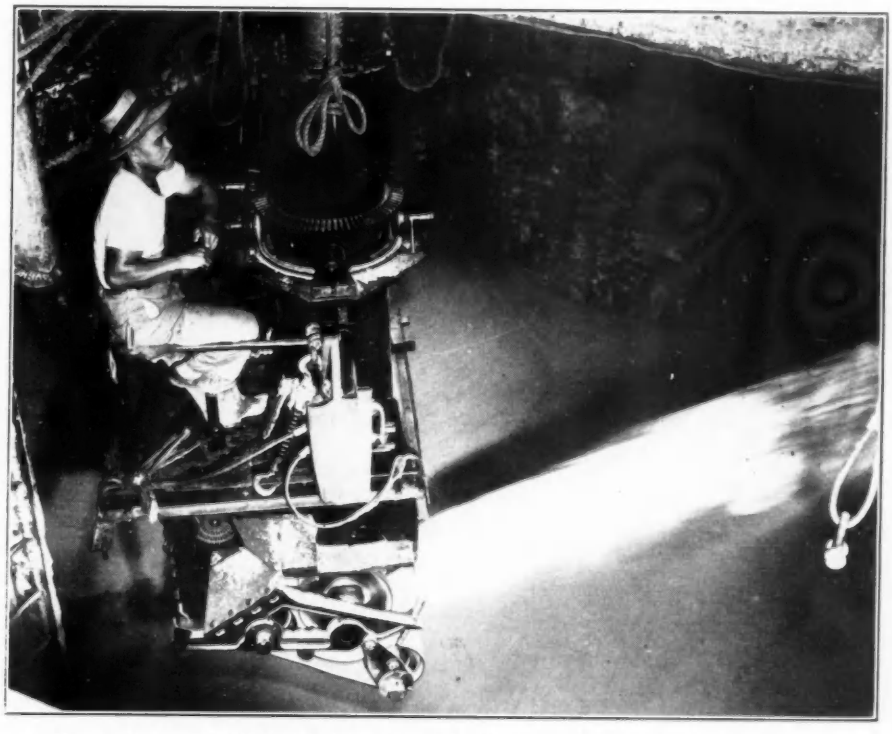
Each year, nearly a million tons of sugar, or about 14 per cent. of the amount consumed by the United States of America are produced on the four major Hawaiian Islands — Kauai, Oahu, Maui, and Hawaii. Twenty-eight plantations on these four islands make raw sugar shipments through seven island ports. Prior to 1942, all shipments were made in 100-pound burlap bags, but since then the sugar production of Maui, i.e. about 15 per cent. of the total Hawaiian production, has been sent to the Californian and Hawaiian Corporation's refinery at Crockett, California in bulk form, thus dispensing with the use of bags.

Since December, 1949, practically all the sugar produced on the large island of Hawaii has been shipped in bulk form, and since July, 1950, this commodity has been shipped from the newly completed Nawiliwili bulk plant on Kauai. The three plants now in operation in the Hawaiian Islands make it possible to ship about 60 per cent. of the sugar crop in bulk form.

Long before any action was taken to develop bulk handling of raw sugar, Hawaiian industrialists had observed the development and widespread use of bulk handling of other materials such as grain and cement. It was realized that while bulk handling of raw sugar could be adopted, it would require careful planning and large capital investment. With the outbreak of war in 1939 the growing difficulty of obtaining dependable supplies of burlap for bags indicated that it would be desirable to adopt bulk handling methods. Rising costs of handling cargoes in Hawaii and on the main land was another factor.

The first bulk sugar storage plant was built at the port of Kahului on Maui early in 1942; it is of wooden bin construction and has a storage capacity of 30,000 tons. The sugar is delivered to the plant in rail cars and trucks; when shipments are made, the sugar flows by gravity through openings in the floor of the bins to belts which carry it to the holds of the steamers. Loading is accomplished by the use of Sinden trimmers which throw the sugar in a stream into all parts of the hold.

While the Kahului plant was being constructed, preparations were made to unload



Bulk sugar is loaded into the hold of a sheathed ship by a trimmer at Kahului, Maui. The operator directs the trimmer to put sugar evenly in the hold of a ship. Later models installed at Hilo and Kauai are directed from the deck by remote controls and a man need not be in the hold.

Bulk Handling of Raw Sugar—continued

and store the sugar at the Crockett refinery on the mainland. Two steel gantries were erected at the refinery dock, and these were equipped with continuous chain bucket elevators which could be lowered into the open steamer holds to remove the cargo. At this time no permanent storage facilities were provided at Crockett, the sugar being stored in a section of an existing warehouse.

The first movements of bulk sugar from Kahului to Crockett, California, demonstrated that this method of transportation was feasible, but the onset of the war with Japan made it necessary to postpone further expansion of bulk handling to any of the other islands of Hawaii. It was not until 1947 that the industry was in a position to expand its bulk sugar facilities to other islands and to build additional storage plants. Since then, installations have been installed at Hilo and Nawiliwili, and the plant at Crockett has been completed and is in full use.

Some Special Aspects of Bulk Handling.

Raw cane sugar is about 97 per cent. sucrose, the other 3 per cent. consists of moisture and molasses which gives the coarse sugar crystals a slight stickiness and a tendency to pack under prolonged storage or when subjected to pressure. When first produced, raw sugar can be considered to be a granular material that is somewhat free-flowing, but its tendency to pack has imposed some special problems in bulk handling. Because of its stickiness, the use of pneumatic handling equipment is clearly unsuitable.

The bulk sugar is removed from the plantation mills to the port storage plants either in trucks or rail cars, the latter being used only on Maui. At the storage plant, the sugar is weighed and sampled before entry. Raw sugar is a commodity of comparatively high value per pound, and precautions are taken to prevent any loss or waste. In addition, care is necessary in sampling, because returns to the owner plantation are made on a basis of analysis, showing the sucrose content of each shipment of sugar. Storage facilities are essential at the ports because steamer arrivals are irregular.

After arrival at Crockett, the sugar is again weighed and sampled as it enters the Crockett plant. Here again, extensive storage facilities are required in order to maintain supplies for use during periods when steamers are not docked.

The fleet of C-3 cargo vessels now used by the Matson Navigation Company for transporting the sugar have not required any extensive alterations or additions to handle this type of cargo. The lower holds are generally used for bulk shipments; solid wooden sheathing is used to keep the cargo away from the hull. Eye bolts have been installed in the holds at numerous points to anchor the blocks carrying the cables which operate the dragline buckets used to pull the sugar from back sections of the hold over to the bucket elevator. At the present time the average cargo arriving at Crockett amounts to about 6,500 tons. Ten C-3 cargo vessels and two Liberty type cargo vessels of the Matson fleet are engaged in the work.

The following are some of the advantages of bulk handling of raw sugar:

1. It eliminates the cost of burlap containers.
2. Reduces handling costs.
3. Makes possible more efficient use of steamer cargo space.
4. Reduces time required for loading and unloading steamers.

The developments described above have been made possible by the spirit of co-operation that has long existed among members of the Hawaiian sugar industry. For more than a half century the plantations have improved their methods of operation through research and investigation carried on by the experimental station of the Hawaiian Sugar Planters' Association. Another favourable factor is that the greater part of the Hawaiian output is refined at Crockett, which is owned by the twenty-eight plantations of Hawaii.

The sugar industry has long since established itself as an essential part of the economic life of Hawaii, where the soil and climate are well suited to growing sugar. However, because the Islands are located 2,400 miles from the mainland market, the time required and the cost of moving such large quantities have always been a disadvantage to Hawaii in the face of the competition from the beet and cane areas of the mainland and from Puerto Rico and Cuba, which are much closer to the heavily populated eastern markets.

Bulk handling of materials is a conspicuous trend in many American industries. Hawaii has found this method to be a means of meeting a part of the competition arising from the mechanization of the beet sugar industry. Moreover, the wage rates paid to the sugar workers in Hawaii are higher than those in Cuba and Puerto Rico.

Description of the Hilo Storage Plant.

This plant began shipping bulk sugar in December, 1949. Its storage facilities consist of four steel silos, 80-ft. in diameter and 76-ft. high. Each has a storage capacity of 10,000 tons giving a total of 40,000 tons. Sugar is delivered by overhead conveyor belts; covering the silos is a superstructure housing moving cranes from which are suspended the clamshell buckets used to discharge the sugar. The buckets which have a load capacity of 8,000 lbs., pick up the sugar in the silos and drop it down a sectional discharge tube which extends up through the centre of each steel silo. At the bases of these tubes are conveyors which carry the sugar to the ship.

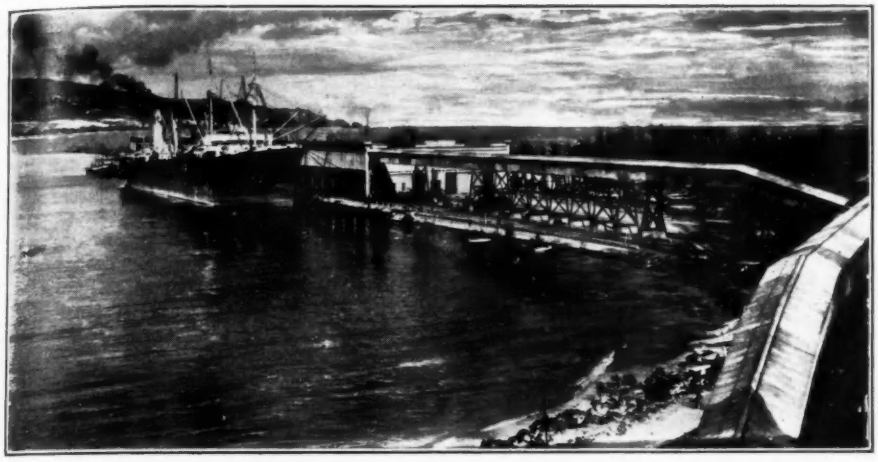
An elevated scale house is provided to receive the truck loads of bulk sugar from the plantations. The sugar is weighed and dumped into receiving hoppers below the floor; it is sampled as it is delivered from these hoppers to a belt conveyor system, which transports it up a series of inclines to the top of the storage warehouse and then delivers it into any one of the four silos.

When a steamer is loaded, sugar is drawn from two silos at a time through the central discharge tubes, a high rate of loading being achieved. The discharge tubes are six-foot lengths of steel pipes, six feet in diameter, and are added section by section as the sugar builds up in the silo when being stored. Conversely, when the sugar is being taken from the silos the tube is removed section by section as the level of the sugar in the silo gets lower.

From the bottom of the sectional discharge tube, sugar is carried on to parallel

Wharves at Hilo harbour, Hawaiian islands. Bulk handling system in the background with two gantries on the wharf to discharge into ship holds.

Bulk Handling of Raw Sugar—continued



Port of Kahului, Maui, Hawaiian Islands. Picture taken from top of bulk storage house. Covered conveyor system is shown to right and centre as it runs into wharf building and to two gantries.

conveyors up a series of inclines to the top of a tower, from whence another series of conveyors transports it to the dock. The last section of these conveyors is parallel to the face of the dock and delivers the sugar to two ship-loading gantries, which travel on rails and can serve any of the steamer hatches. Conveyors on the gantries deliver sugar into a downspout at the end of a boom. At the lower end of the downspout, a Sinden trimmer distributes the sugar in a stream into all areas of the hold.

Description of the Crockett Installation.

This plant consists of nine steel silos of the same type and size as those at Hilo. Construction began in April, 1947 ; five of the silos have been in use since June, 1948, and the other four since 1949. The combined storage capacity of this plant is therefore 90,000 tons.

Briefly, the Crockett installation consists of the following:

Three ship unloading gantries are located on the refinery dock. These are arranged to travel the full length of the steamer so that sugar can be removed from any hatch, and delivered to a receiving conveyor running parallel to their line of travel. The conveyors deliver the sugar to a scale tower where it is weighed in hopper type scales, and sampled. After leaving the scale tower, the sugar is carried on a series of inclined belts to the top of the storage warehouse where further conveyors deliver it into any one of the nine silos.

Sugar is removed from these silos by gravity, through a central discharge tube supplemented where necessary by clamshell buckets operated by an overhead travelling crane. The buckets have a load capacity of 3,500 lbs. At the bottom of the central discharge tube, sugar is delivered to a belt conveyor. A series of these belt conveyors transports the sugar to the refinery where it is again weighed before delivery to the melt station for refining.

Description of the Nawiliwili Plant.

The newly completed Nawiliwili plant, like the Kahului plant, is of the "flat floor" type, whereas the Hilo and Crockett installations are of the " silo " type.

The Nawiliwili plant, which has a storage capacity of 24,000 tons, is located on a bluff about 100 yards from the shipping pier. It is geared to handle an average of 600 tons per hour, the sugar being delivered into the plant by an overhead conveyor belt. It is discharged from the storage area by a subfloor belt conveyor, being moved to the discharge belt through gate openings which regulate the rate of flow. Much of the sugar flows to the belt by gravity, the remainder being moved by two large motor shovels which push and carry the sugar to the gate openings.

The approximate cost of the Crockett installation is $2,500,000, and of the installations at Hilo, Kahului, and Nawiliwili, $4,500,000.

Ship Fires in Ports

Review of Present Procedures and Practices

By Capt. H. V. HART, R.N.R. (Rtd.).

In a certain periodical devoted to maritime affairs, there recently appeared a short commentary upon the number of fires in ships which have lately occurred in ports, with particular reference to the cases of the *Empress of Canada* and the *Kronprins Frederick*. Emphasis was placed upon the ultimate serious consequences resulting from these fires, not only with regard to the complete total loss of valuable vessels concerned, and the pecuniary losses incurred by owners, and underwriters, but also, the disastrous repercussions upon the Port Authorities. To the latter, such casualties prove a serious liability, and a source of severe financial loss, with regard to both the subsequent salvage operations incurred in the removal of the vessel, and also in the deprivation of a valuable berth (or berths) in the dock, during the necessarily protracted period of salvage.

The commentary raises several questions, and passes certain strictures upon the prevailing procedures and practices connected with ship firefighting, some of which contain an element of truth, and others, which require qualification and refutation. The occasion may therefore be opportune, and provide interest, to discuss the criticisms as expressed in this commentary.

It is firstly suggested therein, that ship fires in ports are principally dealt with by local shore fire brigades, to whom the question of stability is of minor importance, as an unknown factor to themselves, and that their operations are conducted with the sole idea of extinguishing the fire, by the pumping of an unlimited amount of water into the vessel, irrespective of any effect upon the vessel, other than the extinction of the fire. Obviously, the primary duty of a fire brigade *is* the extinction of the fire, and it is towards this purpose, that preliminary efforts should be directed, but as the operations progress, and become protracted, due regard must also be given to the possible condition of the vessel in connection with stability, and in the past, it is undoubtedly true, that this essential factor has been widely ignored.

Prior to the late war, too, in one certain major port, at least, fire fighting operations were seriously affected by the fact that various sections of the extensive dock systems were contained within the boundaries of three separate boroughs, the respective fire brigades of which operated independently with varying degrees of efficiency, and in a spirit of reluctance (at least!) to invoke the obviously necessary assistance of a rival brigade, until the last possible moment. With the advent of the war, however, and during its continuance, the various fire brigades became incorporated into a single entity, and under single administration and operational authority. Upon reversion to their respective boroughs, at the conclusion of the war, and as separate units, they now operate in a spirit of mutual co operation, which provides increased efficiency.

Then, too, the educational requirements, and technical training of firemen have advanced considerably and their textbooks contain extensive reference to this all important question of stability at ship fires, and their directing officers invariably seek for information upon this point, on all such occasions.

Coupled with the comments on the activities of firemen, and ship stability, was the suggestion that on the occasions of ship fires, information with regard to the stability of the vessel should be

Ship Fires in Ports—continued

obtained from the officer in charge. If available, this is always advisable, but unfortunately, such information is strictly limited to the inherent stability (or otherwise) of the vessel, under certain conditions of loading, and trim, and (possibly) also, her degree of stability—i.e. G.M. at the time of the outbreak of fire. In common with all other officials present, the ship's officer is entirely ignorant of changing conditions of stability during the operations, as " he cannot tell where the water is going to in the vessel "!

The usual preliminary sign of instability of the vessel is, of course, the visible tendency to list, and to an increasing degree, as operations progress, but alternatively, a slight degree or list, which is apparently stabilised, is by no means indicative of actual stability in the vessel. Cases have occurred where operations have been suspended upon the development of a slight listing of the vessel, which has then later suddenly listed heavily, and capsized. This is probably caused by the formation of pockets of water accumulating in the topsides of the vessel, suddenly finding release, and pouring down towards the low side.

The question of dealing with fires in a passenger vessel is usually a difficult and complex one, as so large a number of confined spaces are available for lodgement of " loose " water, and in a fire of any magnitude, where operations are restricted to the quay and overside, it is impossible to observe into which parts of the vessel, the water is ultimately proceeding.

In cargo vessels, the problem becomes much simplified, as in most cases, it is only the holds which become involved, which, even if filled with water, does not cause undue instability in the vessel.

Another suggestion put forward by a prominent shipping authority, was that of " flooding all holds of a passenger liner, in order that she might settle in the dock in an upright position." This is by no means a practicable proposition, except in the most unusual circumstances. If the fire is not of a serious nature, it is preferable to concentrate on its extinction, and the question of sinking the vessel does not arise. If the fire is of obvious, or likely magnitude, the firemen will soon be unable to remain on board for a sufficient length of time to complete such a lengthy operation as suggested, and additionally, the case is then presented of a vessel partly full of " loose " water and in a consequent dangerous condition. Incidentally also, if the actual " sinking " is accomplished, the vessel is by no means certain to sink in an upright position, unless in an extremely shallow dock. The feasibility of sinking a vessel in a dock largely depends upon the depth of water therein, as certain docks maintain normal depths up to 45-ft., and the operation of sinking a vessel, full of " loose water," through a depth of 20-30-ft., with a probable list, initially imposed by the usual slope of mud as accumulated alongside the wall berth, would constitute an extremely hazardous action, and as such is not to be commended. In shallow docks, where the vessel's draft is not much less than the depth of water in the dock, this action is both feasible and customary. It is also common practice to lower the level of the dock water, until the vessel takes the ground, wherever tidal conditions, and other circumstances relating to other vessels in the dock, permit. In connection with this, it must be noted that a vessel's draft increases with the list, and therefore, on an even dock bottom, the inclined bilge of the vessel will first take the ground and tend to correct the list.

A further point also arises in connection with " flooding to sink." In all cases of entry of water into a vessel, whether into holds or ballast tanks, this remains as " loose " water until the compartment has been " pressed up," and until this has been completed, the action of filling provides a potential source of danger to a vessel in an unstable condition. Several cases have occurred in which vessels leaving ports with homogeneous cargoes and notably with those of case oil, have exhibited instability and have filled ballast tanks to counteract this condition, which action has, in more than one instance, caused in capsizing and loss of the vessel.

Unless the flooding of ballast tanks is made practically instantaneous, as in the case of a submarine when flooding compartments for diving purposes, this action always entails risk to a vessel which is then in a condition of doubtful stability.

A last and most important point raised in the commentary was that of the identity of the official, or person, upon whom devolves the authority and responsibility for making and issuing a decision upon the continuance or cessation of actual fire fighting operations, in particular, and for other essential instructions in connection with ship fires in ports. The suggestion is made that shipowners, marine superintendents, shipmasters, officers in charge of vessels, dock officials, fire brigade chiefs, etc., all take a hand in the formulating of such decisions, with doubtless varying opinions, and inevitable confusion, to the inevitable loss of the vessel.

In fact, who, if anyone, is in complete authority over all operations involved in the casualty?

With over 30 years' marine administrative, operational and salvage experience, in one of the world's largest ports (in U.K.), the writer can present no better answer to this pertinent question than by detailing the procedure adopted in that port and one which appears to provide the most satisfactory solution to the question.

Upon notification of a ship fire in the port, and consequent to information being passed to the appropriate fire brigade, the Port Authority's own salvage and fire fighting tenders are warned of a possible emergency. If the fire becomes, or appears liable to become of a serious nature, these vessels are at the disposal of the fire brigade upon request and automatically act under their orders and control.

At the same time, two senior officers of the Port Authority at once proceed to the scene of the casualty. These officials are seamen of the highest qualification and experience in all port duties, and are separately in charge of the entire marine side of the harbour and docks. It is on these officials that responsibility rests with regard to the general conduct of all operations on the vessel with, if in final disagreement, the ultimate " say so " with the official in charge of all salvage operations. In the majority of serious cases, too, the General Manager of the Port Authority, or his representative, is also present to uphold, if necessary, the decisions of his technical officers. Additionally, a representative of the owners of the vessel, in the form of the Marine Superintendent and of the ship's personnel, will be available for consultative purposes. The fire brigade remain in sole control of all actual fire fighting operations until, and if, it becomes necessary to decide upon the cessation of such. In this port, at least, there exists no question in the minds of all engaged or connected with the operations as to the official who possesses and exercises, when necessary, the authority to make decisions with regard to the casualty.

The responsibility, as on occasions to be assumed for deliberately allowing a valuable vessel to burn out, is a very heavy one and only to be undertaken as an alternative to a probable even more serious casualty which would occasion a far greater loss to all concerned.

Instances *have* occurred in ports where it has been a case of " too many heads " (and opinions) with nobody empowered with final authority and others where in spite of sound judgment and extensive experience the unexpected has happened with unfortunate results.

Again, too, and particularly in the past, the strongest protests have usually been made by the fire brigades against the decision to discontinue further efforts to extinguish the fire, and without absolute authority, such protests, with the often inevitable "kicks" after the event, were difficult to disregard.

A noticeable feature in fires in passenger vessels is the extraordinary rapidity with which the fire spreads from its apparent moment of origin, and in one instance within the writer's experience, this resulted in one-third of the vessel being ablaze within 20 minutes of its initial discovery.

The most effective remedy against these fires in ports would appear to be, as far as possible, the complete sealing of various sections of the vessel by fireproof doors and the introduction of increased inspecting and watching personnel especially immediately after the conclusion of the day's work at which times ship's fires are most prevalent.

Whether these fires are caused through the much debated agency of " sabotage " or through the carelessness of workmen or ship's personnel is questionable, but the deplorable fact remains that these casualties, resulting from ship fires in ports, constitute a major disaster to owners, underwriters and port authorities and a reduction in number of such to be effected calls for careful consideration and action.

Sea-Wave Recording

A survey of the methods of wave measurement and recording used by the National Institute of Oceanography

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Introduction.

THE National Institute of Oceanography and its fore-runner, the Oceanographic Group of the Admiralty Research Laboratory, have studied sea waves extensively during the past nine years. Although the methods used for analysing the wave records have been described (Refs. 1 to 4) and some of the results of the studies have been published (Refs. 5 to 13), very little mention has been made of the instruments used for measuring and recording waves. The present paper is an attempt to fill this gap by describing briefly the methods currently in use at the Institute. It does not cover instruments and methods used in other countries.

1. Shore-Recording Bottom-Pressure Meters.

These devices measure the fluctuations in pressure on the sea bed caused by the passage of waves overhead. They have to be in water which is shallow compared with the wavelength of the waves to be measured, otherwise they will not feel the full fluctuations in pressure corresponding to the changes in surface elevation. The formula connecting the amplitude p of the bottom-pressure fluctuations with the surface amplitude a_o, the depth of water h and the wavelength λ is:

$$p/a_o = \text{sech } (2\pi h/\lambda) \qquad (1)$$

The ratio p/a_o is approximately 1/2 when the depth of water is equal to 1/5 of the wavelength. This means that a wave recorder of this type will not measure short waves and a record from it is not a true measure of the surface conditions. However, they have many practical advantages over the other types for routine wave measurement and have therefore been extensively used. The lack of response to the shorter wavelengths can be an advantage in certain cases; for example, when the long swell from a distant storm is being studied, the locally-generated short waves would only confuse the record.

Three bottom-pressure metres will be described.

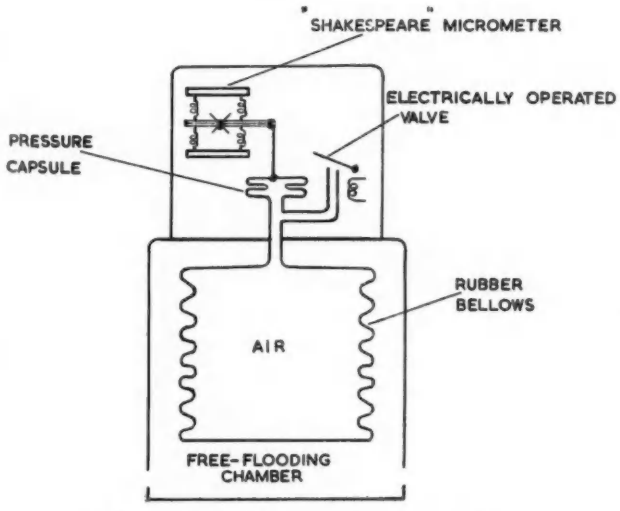

Fig. 1. "Cambridge" Pressure Recorder.

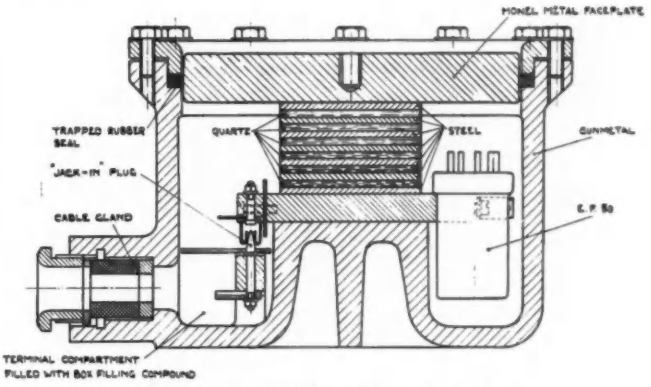

Fig. 2. Piezo-Electric Wave Recorder.

(a) The "Cambridge" Pressure Recorder.

The principle of this device is shown in Fig. 1. The sea pressure is communicated to the air inside the limp rubber bag, and thence to the inside of a capsule similar to that used in aneroid barometers. The capsule is surrounded by air at a fixed pressure which is approximately the average pressure of the water outside the unit, and the pressure differences due to the waves therefore appear across the capsule. The movement of the capsule is measured electrically by either a differential inductance pick-up or a Shakespeare micrometer. This micrometer consists of four spirals of platinum wire which are arranged as a Wheatstone's Bridge and heated by the bridge energizing current. Movement of the capsule causes two spirals in opposite arms of the bridge to close up and become hotter and the other two to expand and become cooler. The accompanying changes in resistance unbalance the bridge by an amount proportional to the displacement. The device is surprisingly stable.

The capsule is bypassed by an electrically operated air valve which is closed during recording but is otherwise left open to equalize pressure changes due to tides. A six-core cable connects the measuring head to the shore.

In conjunction with a suitable electrical filter this type of recorder may be used to measure long-period waves (Ref. 13).

This instrument was developed during the war by the Cambridge Instrument Company in co-operation with what was then the Admiralty Mining Establishment, now called H.M. Underwater Countermeasures and Weapons Establishment.

(b) The Piezo-Electric Wave Recorder.

Considerable trouble was experienced with the limp rubber bags of the Cambridge pressure recorder. When these were made of thin rubber the air diffused out through the walls and mechanical friction against the protective casting wore holes, so that the useful life of the measuring heads in the sea was only about 18 months. Using stronger and thicker rubber caused the bags to exercise considerable restraint, so that the sensitivity became dependent on the amount of air in the bag. The Piezo-electric wave recorder was developed by the Oceanographic Group of the Admiralty Research Laboratory to overcome these difficulties, and is shown in Fig. 2.

In principle it is a very low frequency quartz hydrophone. The sea pressure acts directly on the outside of a 6-in. diameter faceplate, which acts like a piston and transmits the force to a pile of six quartz discs interleaved with steel. Changes in this

Sea-Wave Recording—continued

force cause the quartz discs to produce electric charges (the Piezo electric effect) which flow into a capacitor and produce a voltage proportional to the pressure. A pressure change of between 20 and 30 feet of water is required to produce a potential difference of one volt across the capacitor. The fluctuating voltages are amplified electronically, the first valve of the amplifier being in the sea unit to avoid the necessity of maintaining extremely high insulations in the cable. Any steady charge on the condenser slowly leaks away, and the time-constant (10 seconds) of this leak is adjusted so that the device only measures the comparatively rapid

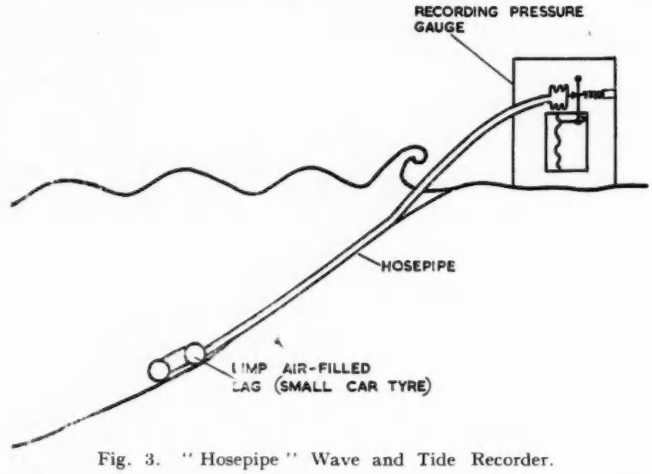

Fig. 3. " Hosepipe " Wave and Tide Recorder.

fluctuations due to waves and does not respond to tides. A seven-core cable connects the device to the recording equipment ashore.

One of the prototype instruments of this type was in operation at the recording station at Perranporth for over five years before becoming unserviceable.

(c) The " Hosepipe " Wave and Tide Recorder.

This device is simple in principle and has been used in many forms by various workers. The principle is shown in Fig. 3. The air in the limp air-filled bag, which is fixed to a weight on the sea bed, takes up the same pressure as the water outside it, and this pressure is transmitted through a strong hosepipe to a recording pressure gauge on shore. The recording pressure-gauge is arranged so that the pressure due to the mean head of water may be backed off by a spring, and pressure changes due to waves and tides are recorded. A tidal record may be obtained by connecting a capillary tube or some other air resistance between the hosepipe and the pressure-measuring bellows, so that the rapid pressure fluctuations due to waves do not pass. If now a second bellows connected directly to the hosepipe is used instead of the backing-off spring, pressure changes due to tides equalize and only waves are recorded.

The length of the hosepipe that may be used is limited, because the air in very long pipes cannot move backwards and forwards fast enough to produce the full pressure changes at the shore end. The N.I.O. usually uses canvas reinforced pressure tubing of ¼-in. internal diameter, and up to about 100 yards of this may be used.

This principle is very useful for portable wave recorders, because no power supplies are required.

2. Shore-Recording Surface-Elevation Meters.

For the majority of purposes for which wave meters are required, the information which would be most useful would be a record of the surface elevation over a fixed point on the sea bed. However, no really satisfactory device has been developed which will measure this under all sea conditions. The devices described below are useful for certain purposes.

(a) Inverted Echo-Sounder.

If an echo-sounder transmitter and receiver unit is inverted and placed on the sea bed, it can be used to measure the vertical distance to the water surface above it. The conventional echo-sounder recorder records this distance as a series of marks on a chemically prepared paper or on " Teledeltos " paper. Such records may be measured by hand but are not suitable for analysis on automatic machines. A circuit has recently been developed by the National Institute of Oceanography which gives a voltage proportional to the echo time, and this may then be recorded in a form suitable for the automatic analysers. It is hoped to publish a full description of this circuit in the near future.

With suitable design the transmitter-receiver unit may be operated at the end of some thousands of yards of cable, and an installation of this type was used to obtain a daily record at Perranporth during a period of 5½ years until deterioration of cable insulation caused its operation to be unreliable.

The main factor limiting this type of instrument is the variable amplitude of the echo received from the water surface. Under moderate sea conditions this is probably due to the varying configuration of the surface, but when " white horses " are fully developed large patches of aeration occur which frequently completely prevent any echo for periods of many seconds at a time. Another limitation is in the size of the area of the water surface " illuminated " by the sound which, with the usual type of equipment operated from a depth of 40 ft., is a circle of about 10 ft. diameter. Waves with a wavelength of less than about twice this diameter cannot be satisfactorily measured.

(b) Capacitance-Wire Wave Recorder.

This device is shown diagramatically in Fig. 4. A synthetic enamel insulated wire of standard commercial manufacture is stretched vertically through the water surface, and the centre conductor and the water form two plates of a capacitor with the in-

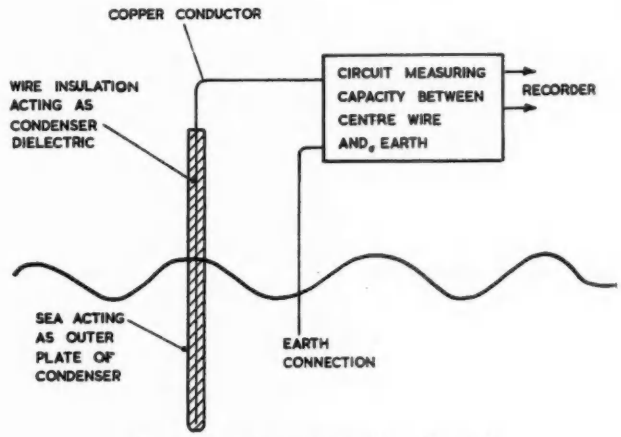
COPPER CONDUCTOR
WIRE INSULATION ACTING AS CONDENSER DIELECTRIC
CIRCUIT MEASURING CAPACITY BETWEEN CENTRE WIRE AND EARTH
RECORDER
SEA ACTING AS OUTER PLATE OF CONDENSER
EARTH CONNECTION

Fig. 4. Capacitance-Wire Wave Recorder.

sulation as the dielectric. The capacitance varies with the height of the water up the wire and is measured by a simple electronic circuit. A circuit containing one triode valve will give enough output to operate a mirror galvanometer. The device has so far been used to measure small waves on lakes and in experimental tanks, and in its present form will measure waves up to about 18 in. in height with a maximum separation between the measuring head and electronic panel of a few hundred yards. Attempts to make larger measuring heads have so far failed for mechanical reasons, but it is hoped to make measuring heads that can be fixed to piers or used in conjunction with the pole-and-drogue type of apparatus (q.v.).

This instrument was developed by the National Institute of Oceanography and was exhibited at the Institution of Civil Engineers Conversazione in June 1952. It is hoped shortly to publish a full account of it. We have recently heard by private communication that a similar device has been developed independently by the St. Anthony Falls Hydraulic Laboratory of the University of Minnesota.

Sea-Wave Recording—continued

3. Deep-Sea Wave Meters.

These are devices for measuring waves in places where it is not possible to use the sea bed as a steady platform.

(a) Pole-and-Drogue and Suspended Pressure-Meter Wave Recorders.

The principles of these devices are shown in Fig. 5. They are considered together because their principles are complementary and they are both based on the use as a reference of the still water below the reach of the waves. In deep water the amplitude of the water particle motion and also of the pressure fluctuations at a fixed point falls off according to the law

$$a/a_0 = \exp(2\pi h/\lambda) \qquad (2)$$

The ratio a/a_0 is approximately 1/2 when $h/\lambda = 1/9$.

In the pole-and-drogue device, attributed to Froude, a pole is held vertically through the water surface by means of a buoy and weight. The pole is prevented from rising and falling with the waves by means of a drogue suspended at a depth below the reach of the waves. The motion of the water up and down the pole may be observed visually or may be measured by means of a " hosepipe " recorder with the rubber bag fixed to the buoy. To be below the action of all ordinary waves, the drogue would have to be at a depth of at least 400-ft., but in practice the drogue is often suspended at a depth of 150-ft. At this depth the drogue itself will rise and fall to some extent with the longer waves, which will therefore not be measured accurately: the response of the

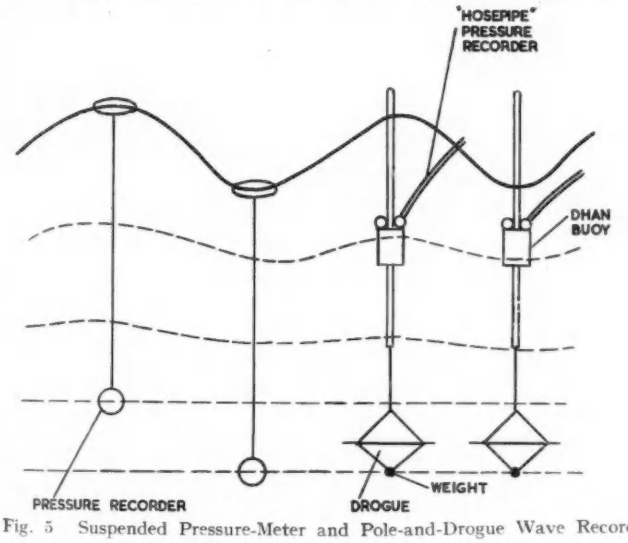

Fig. 5 Suspended Pressure-Meter and Pole-and-Drogue Wave Recorder.

system will be approximately half for waves of 16-second periods, but if appropriate correction is made most wave conditions can be measured satisfactorily. It is necessary to arrange a tripping device which releases one side of the drogue before recovery.

In practice this type of device is never very satisfactory owing to the adjustment of buoyancies being critical and to the difficulty of handling the equipment in rough weather. Great care must be taken to make sure that the ship does not tow the equipment through the water.

In the suspended pressure-meter type of equipment the movement of the surface is followed by a buoy which raises and lowers a pressure-measuring device suspended below the action of the waves. The pressure changes measured therefore correspond to the changes in surface elevation. The Deutsche Versuchanstalt für Luftfahrt employed this method before the second world war for studying seaplane landings, and developed a self-contained pressure recorder in which the pressure fluctuations were recorded by a diaphragm connected to a diamond which scratched a spiral record on a polished steel cylinder rotated and moved along its axis by clockwork. The National Institute of Oceanography has used a Piezo electric pressure recorder for this purpose, and the equipment was connected to the ship by means of a buoyant cable. The response of the instrument to waves of different periods depends on the length of the suspension wire in the same way as in the pole-and-drogue type of equipment.

Once again the apparatus is difficult to handle in bad weather, and also may not be towed, even at slow speed.

(b) Air-borne Wave Recorder.

This device is in effect a recording radar-altimeter with rapid response. The aircraft flies over the sea at an altitude of about 200-ft. and records the distance to the water surface vertically below. The speed of the aircraft is fast compared with that of the waves, and an approximation to an instantaneous cross-section of the sea surface is therefore recorded. It is the only wave recorder which will do this, and has been useful on this account. The instrument was developed by the Telecommunications Research Establishment of the Ministry of Supply, and several have been made by Messrs. Ferranti Ltd.

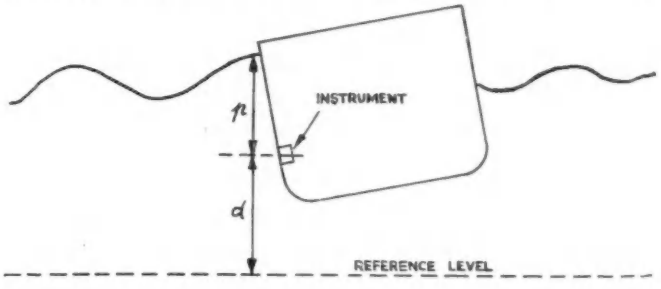

Fig. 6. Ship-borne Wave Recorder.

(c) Ship-borne Wave Recorder.

This instrument was developed by the National Institute of Oceanography, party in response to a request from the Air Ministry Meteorological Office for a wave recorder for use aboard the Ocean Weather Ships. It has already been described in the literature (Ref. 14), but a brief account of it will be given here for the sake of completeness.

The principle is shown in Fig. 6. A measuring head fixed to a point on the ship's hull measures the distance p to the water surface by measuring the water pressure on the hull, and a second device at the same place measures the vertical displacement d. The sum of these readings gives the height of the water surface above an imaginary reference plane, and is independent of the motion of the ship. The vertical displacement is obtained by measuring the vertical acceleration and integrating this twice electronically. Short waves approaching the ship from the side remote from the measuring head may be partially reflected, and a second measuring head is therefore placed on the other side of the ship and the average of the two outputs is taken. The ship must, of course, be stationary if true wave periods are to be measured. The shortest wavelength to which the instrument will respond is governed by the depth of the pressure-measuring units, and this must be such that they never come out of the water surface. On the " Discovery II " this depth was 10-ft. and the response was approximately half for waves of 4-second periods.

Though this device is complicated compared with most oceanographic instruments, it has many advantages. It is contained entirely within the hull of the ship, requires only the throw of a switch to obtain a wave record, and requires a negligible amount of routine servicing. The instrument was operated over a period of about six months in the Institute's research ship "Discovery II." and is now installed in the Air Ministry Ocean Weather Ship " Weather Explorer."

4. Recording the Output of Wave Meters.

Though the instruments so far described are usually called recorders, most are really meters giving an electrical output which must be recorded by a grapher, or graphic recorder.

Sea-Wave Recording—continued

For analysis on the automatic analysing machines the records have to be in the form of black-and-white profiles, and these are usually prepared photographically using a mirror galvanometer to move a line of light in a direction along its length across photographic paper which is being driven at right angles to this direction. The edge of the line traces out the profile, which appears on development. This method of recording has the advantage of requiring only a small output from the wave meter, but is expensive, particularly when frequent routine recordings are taken. Pen-and-ink recorders are cheaper to run, but the records are not directly suitable for automatic analysis and they require considerably larger output powers from the wave recorders. Neither of these methods of recording will run continuously for 24 hours without replenishment of paper.

To overcome some of these limitations the Institute has developed a graphic recorder which records with pen and ink on plain paper tape 35 mm. wide in continuous lengths of up to 2,000-ft. At the usual recording speed of 2-in. per minute, this recorder will run for 8 days without attention. Coded time-marks are put on the side of the tape every hour giving the hour of the day, and a specially " stiff " meter movement is used to reduce frictional effects in the pen which might otherwise reduce the relative accuracy of recording on the small scale used. A photo-electric curve follower is available which will convert selected sections of the record into an electric current varying with time, which may then be re-recorded in a form suitable for automatic analysis. This curve follower is an improved version of one that has already been described (Ref. 15). This system has the advantage that it is possible to build up a reasonably compact library of continuous wave records and the corresponding meteorological charts.

Acknowledgment.

The author wishes to make it clear that the instruments which have been developed by the former Oceanographic Group of the Admiralty Research Laboratory and by the National Institute of Oceanography are the result of team work by many members of the staff.

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New Dry Dock at South Shields

Unusual Method of Construction

This dock which is intended to be built on the south bank of the Tyne at South Shields, occupies a site on the property of Messrs. Brigham & Cowan, Ltd., the well-known ship repairers, which used some years ago to be covered by numerous old buildings and streets of small dwelling houses but in more recent years since the construction by the South Shields Corporation of the new bridge and roadway and the clearance of slum property, the ground alongside the river has been given over to the storage of timber and of contractors' plant.

Very near the position of the new dock is a place where old records mention the existence of a spring of water which was in those days in great request for the healing of eye complaints.

The continued existence of water springs brought to light by the investigations recently undertaken upon the site of the South Shields dock are, however, a source of anxiety rather than of profit, and the engineers are said to be far from enthusiastic or indeed appreciative of the hidden reservoir of underground waters which has been revealed. They would, in fact, be much better pleased if the whole of the strata were of the same quality as the tough boulder clay that outcrops on the surface. Engineers, like beggars, cannot, however, be choosers and this particular site situated as it is upon the banks of a river famous for its shipping and everywhere else crowded with ship building and ship repairing yards, is so naturally advantageous as to make its utilisation imperative. A thorough exploration of the subsoil having been made it has been possible to prepare careful plans whereby it is hoped to counteract geological vagaries during the construction period by de-watering the strata with the help of the recently developed tube well technique, and to counteract them after construction is completed by other methods equally effective.

It was mentioned recently that the plans submitted for approval of the Port Authority showed the adoption of a rather unusual type of dock wall. Most of the old docks built between fifty and a hundred years ago followed a pattern where stability was achieved by sheer weight, the dock walls reclining backwards in a series of altar steps which imparted to graving docks a somewhat monumental appearance.

Very recent docks, of which one or two have been built in this country and several in Europe, affect a coffin like profile, the sides

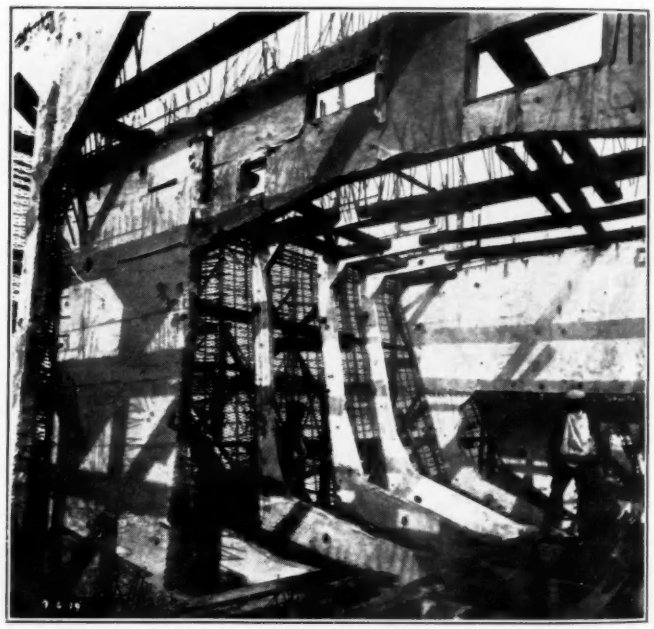


Fig. 1. Reinforced concrete ship construction in 1918.

internally being nearly vertical. Messrs. Brigham & Cowan's new dock does not altogether follow either pattern, the side walls with the altars do in fact have a slight inclination backwards but are ribbed like the sides of a ship. The ribs run right up from floor to cope and are formed of precast reinforced concrete units each of which weighs about ten tons and is erected by a crane in one piece.

Somewhat similar ribs were made use of in the reconstruction of the Barry Commercial Dock with the difference that whereas the Barry Dry Dock Ribs constituted a skeleton framework behind which the water extended right up to the old dock walls (which were too wide apart), in the South Shields construction the ribs are part of the wall structure, they being connected together monolithically and laterally by means of a solid sheet of concrete cast in situ between them and in intimate contact with both the ribs and the natural strata behind.

New Dry Dock at South Shields—continued

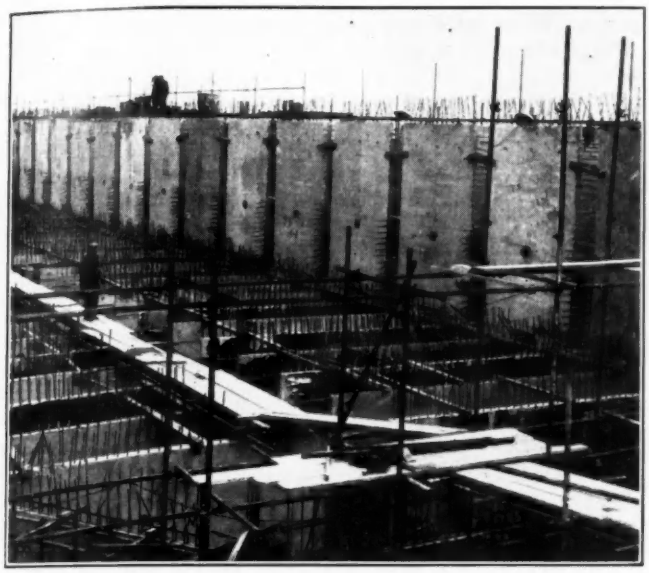


Fig. 2. Reinforced concrete Floating Dock construction in 1944.

Having regard to the tough quality of Boulder Clay within whose embrace the walls of this dock happen to lie, the rib form of construction has been found to be the economical solution, but, of course, every dock job differs from another and what may be the economical solution in one case would not be so in another.

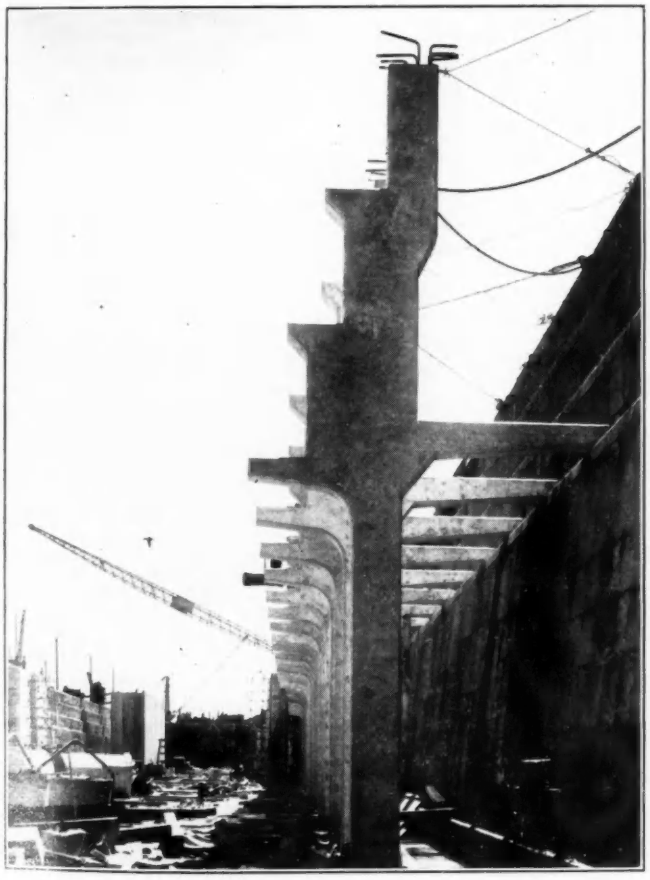


Fig. 3. Precast R/Concrete Piles erected at Barry Commercial Graving Dock.

In the matter of economical design it has to be borne in mind that the manufacture of concrete has nowadays reached a comparatively high pitch of perfection, and the cost of producing a high quality concrete article is not really appreciably greater and may in some cases be positively less than the cost of producing one of inferior quality.

The old-fashioned mass concrete wall brought up in lifts of about 3-ft. high between timber shutter walls was a low quality article and has not much to recommend it nowadays, because the placing of the shutter work has become exceedingly expensive, the making of a good horizontal joint between successive lifts is never very satisfactory, and the cost of the large quantity of broken stone, sand and cement called for in this type of construction is quite formidable; also the inability of the material to take any tensile stress is a serious disadvantage. The precast, and to some extent, reinforced concrete unit is weight for weight admittedly more expensive than masswork concrete but a little of it goes a long way. If, moreover, the manufacture of the units be standardised as is

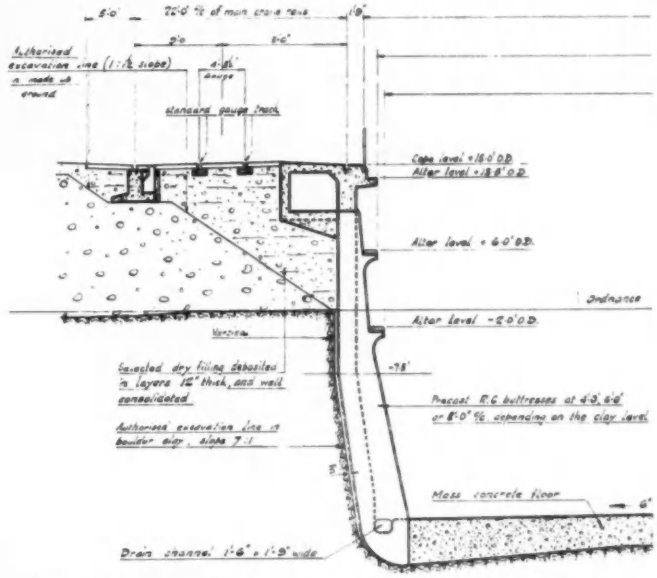

Authorised excavation line (1:½ slope) in made up ground
Standard gauge track
Cope level +18·0 O.D.
Alter level +18·8 O.D.
Alter level + 6·0 O.D.
Ordnance
Alter level −2·0 O.D.
Laid dry filling (obsolites in layers 12" thick, and well consolidated
Precast R.C. buttresses at 4·0, 6·0 or 8·0" c/c depending on the clay level
Authorised excavation line in boulder clay, slope 7:1
Mass concrete floor
Drain channel 1·6" × 1·9" wide

Fig. 4. Drawing of Rib to be used in the South Shields Dock.

the case in these dock ribs, a lot of ribs can be cast lying flat one on top of another with a sheet of paper or a coat of whitewash separating them, and the curb shutters can be used many times over so that the cost does not, in fact, work out as very high in the end.

Ribs of this kind and cast in this way were used, but in a primitive way, in the building of concrete vessels as far back as 1918. Fig. 1 shows the ribs with bits of parting paper still attached. The system, was, however, really developed during the last war when it proved most successful in economising time and labour in the manufacture of concrete floating docks. Quick to seize on a good idea, the Americans copied the system for their own floating concrete structure programme about a year after it had been developed in the United Kingdom.

Fig. 2 shows precast ribs and walls of a floating dock built near Liverpool in 1944. Fig. 3 shows precast concrete ribs erected at Barry Commercial Graving Dock. Fig. 4 is a drawing of one of the ribs which is proposed to be used in the South Shields Dock.

The Engineers responsible for the works above referred to are Messrs. Maunsell Posford & Pavry, Abbey House, London, S.W.1.

Improvements at Port Swettenham.

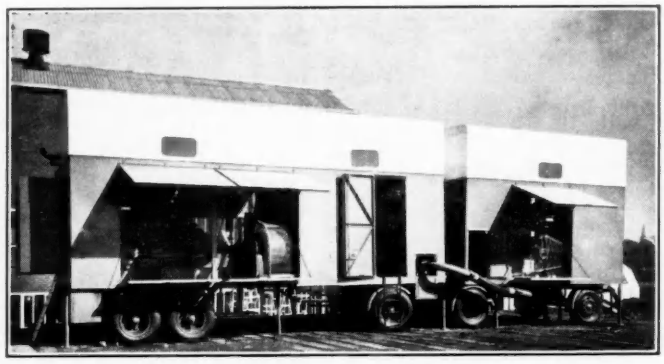
Port Swettenham, the port serving Kuala Lumpur, the Malayan capital, will be enlarged at a cost of £3,500,000 during the next five years, to enable it to handle more than 800,000 tons of goods. At present not all the ships entering the port can be accommodated at the wharves and some have to employ lighters to unload their cargoes.

Mobile Grain Handling Plants

Equipment Supplied to Turkey

Owing to rapid improvements in agriculture in recent years, Turkey nowadays has a substantial surplus of grain available for export, far more in fact than can be dealt with by the existing storage and handling facilities at the Turkish grain-shipping ports. To meet the situation until permanent installations can be built, the Turkish Government in 1952 decided on an interim handling and storage system comprising prefabricated huts and a fleet of road trailers carrying grain handling, cleaning and weighing machinery. The scheme is designed not only to provide emergency handling and storage facilities but also to substitute bulk handling and storage for the laborious manhandling of grain in sacks.

Simon Handling Engineers Ltd., Stockport, England, were invited by the Turkish Government to design suitable types of portable handling equipment, and in June 1952 they received a contract of over half a million pounds for forty-eight special trailer-mounted units. These units will serve four purposes: first, they will discharge grain arriving at the ports in road and rail vehicles into bulk storage in Quonset huts ; secondly, they will " turn over " grain from one hut to another, if this should be necessary to keep it in condition during prolonged storage; thirdly, they will



View of Mobile Grain Handling Plant.

load grain from the huts into road and rail vehicles for transit to the actual quay side; fourthly they will discharge grain from vehicles at the quay side into ocean-going ships for export.

To meet these requirements the road trailers comprise one main and two auxiliary types. The main trailer carries suction/blowing equipment which can withdraw grain under suction from one point and discharge it under pressure to another point; this unit can be used either alone or in combination with either of the two auxiliary types; one of which carries grain cleaning and weighing machinery while the other carries weighing machinery only. The contract placed covers twenty-four main trailers and twelve each of the two auxiliary trailers.

In normal service, twelve of the suction/blowing units will operate with the twelve cleaner/weigher units for discharging incoming grain from road and rail vehicles into huts; in other words, all grain will normally be cleaned and weighed before being put into storage in the dock area. The same twelve suction/blowing units will be used alone, for transferring grain from huts to vehicles for transit to ships at the quay side. At the quay side the other twelve suction/blowing units will operate with the twelve weigher units for loading weighed consignments of grain into ships. Portable lengths of steel piping and flexible piping with quick-acting couplings are provided for connecting the suction/blowing trailers to grain intake and delivery points and for inter-connecting the main trailers with the auxiliary trailers when required.

Construction and Operation of Trailer Units

(a) **Main suction/blowing unit.** The main trailer carries a Rootes-type exhauster, driven by a 165 h.p. diesel engine, which provides suction for the intake of grain from vehicles or storage huts and pressure for the discharge of grain to delivery points. It also carries the grain receiver and main pipe connections. Incoming grain is delivered under suction to the grain receiver, where it is separated from the conveying air stream by a high-efficiency cyclone mounted inside the receiver. The air then passes into the suction inlet of the exhauster by way of a grid for arresting airborne particles and is discharged under pressure into the exhauster outlet pipe.

Grain is discharged from the receiver through a rotary air seal, on leaving which, it can follow any of three alternative routes. When the main trailer is used alone the grain can be delivered straight into the exhauster pressure pipe to be blown to any desired delivery point, or alternatively it can be diverted by a hand-operated valve into a chute feeding to portable belt conveyors. When the main trailer operates in combination with one of the auxiliary trailers, the grain is delivered by way of the chute into the boot of a bucket elevator mounted in the auxiliary trailer.

(b) **Cleaner/weigher unit.** This unit contains an "Apex" rubble separator and a pair of Simon " Reform " automatic weighers mounted side by side. Grain from the suction/blowing unit is received in the boot of a bucket elevator, which discharges it into the rubble separator; the rubble removed is delivered to sacking-off points on either side of the trailer, while the cleaned grain is received by a second bucket elevator and fed into the top hoppers of the two automatic weighers. The weighed grain is then delivered through a pair of rotary air seals into a pressure delivery pipe coupled up from the exhauster outlet of the suction/blowing unit. A small diesel engine is carried on the trailer for driving the bucket elevators, rubble separator and rotary air seals.

(c) **Weigher unit.** The weigher trailer is similar to the cleaner/weigher trailer except that it lacks the rubble separator and consequently has only one bucket elevator. Grain from the suction/blowing unit is delivered into the boot of this elevator and fed to the weighers, from which it can be delivered on either side of the trailer through rotary air seals connected to an extension of the pressure outlet pipe from the suction/blowing unit. As in the case of the cleaner/weigher unit, a small diesel engine is provided for driving the bucket elevator and rotary seals.

(d) **Chassis and housings.** The chassis of each of the three types of trailer is constructed of rolled steel sections strongly braced by cross-members. The main suction/blowing trailers are mounted on three axles and the auxiliary trailers on two ; all wheels have large-section pneumatic tyres, and the axles are suspended on semi-elliptic leaf springs. Adjustable screw-jacks are fitted at the corners of the chassis to keep the trailers level and steady while operating.

The machinery on each trailer is enclosed in a single rectangular sheet steel housing with large access flaps at the sides. During operation the upper flaps are opened upwards and supported on stays, while the lower flaps are opened downwards and held horizontally to provide extra floor space. All the trailers have generators and storage batteries for internal electric lighting.

The suction/blowing unit can receive and discharge grain at 45 tons per hour when collecting and delivering, over distances up to 100 feet. The cleaner/weigher and weigher units can each handle up to 50 tons per hour; thus having a slight reserve to prevent any risk of overloading the cleaning and weighing machinery when the suction/blowing units are working at maximum capacity.

Hamburg Regulations on Oil Pollution.

Since the beginning of last month, vessels in the port of Hamburg have been prohibited from pumping oily water or waste oil into the harbour, and a special area has been set aside on the small island of Hohe Schaar, in the Reihestieg area, for the collection of such oil. The " Hamburger Anzeiger," reports that originally, it was intended that all oil-polluted liquids should be pumped into enclosures, where the water could soak through, leaving the oil on the surface, to be burned. A Hamburg firm now proposes to establish a special service for recovering oil from the cleanings of oil tanks and bilge water, and tanks with a total capacity of 5,000 cubic metres are to be erected in the Neue Petroleumhafen for dealing with the oily water. The firm will only accept liquids containing a certain percentage of oil; others will be sent to Hohe Schaar. It is stated that between 1938 and 1945 the firm extracted 60,000 tons of usable oil from about 85,000 tons of dirty marine fuel oil.

Oil Pollution of the Sea

Speeches at Recent International Meeting

(Specially Contributed)

An international conference on oil pollution of the sea was held at the Institution of Electrical Engineers, London, on Tuesday, October 27. It was convened by the Co-ordinating Advisory Committee on Oil Pollution of the Sea and was presided over by the chairman, Mr. James Callaghan, M.P. Delegates from over 25 countries, with British shipowners and representatives of dock, harbour and local government authorities, attended. The object of the conference was to stimulate public interest in the recommendations in the report of the Committee on the Prevention of Pollution of the Sea by Oil, set up by the Ministry of Transport, and to emphasise the need for international action to implement the recommendations as soon as possible.

The report of the Ministry of Transport Committee was summarised in *The Dock and Harbour Authority* August issue.

Mr. James Callaghan, in opening the conference, said that this was the first occasion on which representative citizens from many different countries had met together to consider what action could be taken to stop the growing menace of oil pollution. Those who had organised the conference believed that the committee which recently reported to the Minister of Transport was right in finding "that the aim should be to avoid altogether the discharge of persistent oils into the sea." They hoped that the result of their discussions, and of the Declaration of Aims, would be to stimulate the Governments of the principal maritime nations to agree among themselves to take all measures that might be necessary to end the scourge of oil pollution of the seas and coasts of the world.

Mr. A. T. Lennox-Boyd, Minister of Transport and Civil Aviation, emphasised that all could help in ending the scourge of oil pollution—public opinion, governments, shipowners, dock and harbour authorities, and oil companies. He recognised the real responsibility which the United Kingdom Government had in this matter and, in fact, the Government had, in advance of the Faulkner Report (as the Government Report was called) made a factual survey of the problem, and then invited those interested to be associated in the committee. It was realised that legislation was required to implement the recommendations of the committee's Report and that action by one country alone, although important, was not enough. The Government were therefore taking steps to invite other maritime Governments to a conference to discuss the problem.

The Government had in mind arrangements similar to the highly successful 1948 conference on Safety of Life at Sea. That conference's Report was followed by action, and it was intended that action should also follow the proposed conference on oil pollution. British shipowners, with a sense of duty and without waiting for legislation, had advised the voluntary adoption of the recommendations of the Faulkner Report, and the major oil companies, and the dock and harbour authorities, had said that they would do all they could to provide facilities for the reception of waste oil from ships.

Lord Hurcomb, chairman of the Society for the Promotion of Nature Reserves, and a member of the Council of the Royal Society for the Protection of Birds, until recently chairman of the British Transport Commission, was the next speaker. He said that there was no dispute as to the gravity and extent of the mischief. It was not possible to rest on our sands or to paddle along our shores without disagreeable adhesions to clothes or feet, and tens of thousands of sea birds were doomed every year to a cruel and lingering death. Nor was there any room for dispute as to the cause of the trouble or the remedies for it. The remedies were clear and all that was needed was the will to apply them. It would no doubt be pointed out, quite fairly, that the problem was an international one, but that was no reason why much effective action could not be taken without delay by individual countries.

It would also be said that the remedies cost someone some money, but that was not a valid objection. The cheapest way of dealing with industrial emissions and effluents of all sorts might be to pour them untreated into the air, the rivers or the sea, which were common property; it was high time that these practices were stopped.

He congratulated the Faulkner committee on the speed and admirable precision of their Report, which was produced within ten months of the committee's appointment. Their inquiries had been thorough and they had pointed firmly and fearlessly to the remedies, after satisfying themselves that those remedies were entirely practicable. They had taken every cause of trouble and each class of ship one by one, and shown clearly what was needed to minimise, and eventually to abolish, the present evil.

It came down to this, that the only way to avoid polluting the sea, fouling our beaches and destroying our birds was not to put persistent oily sludges and waste into the ocean, but to separate them and to discharge them ashore. Nothing less would suffice. To prohibit discharge within a prescribed distance of particular coasts was merely a palliative, though necessary as an interim measure.

Thirty years ago a committee of British shipowners recommended that oily water should not be discharged from ships within 150 miles of our coast, and a year or two later a conference in Washington recommended that each country should determine a zone for itself, and mentioned 50 nautical miles as a limit. No general agreement was secured, but British shipowners and those of some other important maritime countries (the United States, Belgium, Netherlands, Sweden and Norway) voluntarily adopted a 50-mile limit. In 1936 the United States asked for observance of a limit of 100 miles for their coast, and British shipowners generally agreed to honour this request, showing once more their enlightened attitude. Nevertheless, the shipowners of many countries did not yet observe the 50-mile limit.

But it should be realised that even a limit of 150 miles would not give the United Kingdom a complete remedy. Experiment had shown that 15 tons of fuel oil discharged in a calm sea—and fuel oil was the chief source of damage to birds—had spread over eight square miles six days later and films of crude or fuel oil which thinned out and seemed to disappear in the open sea still persisted invisibly and ultimately drifted ashore and caused oily deposits on beaches. How heartily then, must they agree with the Committee that the only long-term policy was to prevent the discharge of persistent oil into the sea altogether. To that policy all maritime countries and their shipowners and the producers of oil, had to be persuaded to agree and to contribute, as soon as possible.

To make this practicable it was essential that suitable and adequate facilities for the reception of oily waste from deep sea tankers should be provided at all loading terminals and repair ports throughout the world. This step was, in fact, advocated by the British shipowners' committee thirty years ago; yet the present committee found that, with some exceptions, such facilities were inadequate or non-existent even in United Kingdom ports, and that other countries, apart perhaps from the U.S.A., were worse equipped than we were. The Committee therefore recommended that the oil companies should provide adequate reception facilities at all loading terminals in the United Kingdom and throughout the world. The oil companies were not unsympathetic or unenlightened in this matter, and as they were few and powerful, they might surely hope for rapid and comprehensive action on their part. Similar obligations should be placed upon ship repairers and also, more particularly as regards dry cargo ships, upon dock and harbour authorities, who should be entitled to provide or arrange for the necessary facilities and, where they provided them themselves, to level reasonable charges for their use. The Minister should be empowered to require these authorities to take action if compulsion was found necessary. The British Transport Commission, in which so many of our busiest commercial ports vested, had already assured the Minister that they would do everything in their power

Oil Pollution of the Sea—continued

to ensure that the Committee's recommendations were carried out.

Once shore facilities for the reception of oily wastes were on the way to becoming adequate, the path for rapid progress by shipowners in fitting separators on board would have been smoothed and the period which must elapse before full obligations not to discharge at sea could be placed upon them would have been shortened. A large proportion of the pollution resulted from crude oil sludge and washings from tankers, but it appeared that over 80 per cent. of the volume of their contaminated water could be discharged overboard without including more than a negligible amount of oil. Thus " fortunately " (to quote the Report) " tankers can readily deal with their oil residues within the ship and contain them for discharge ashore if shore facilities are available." Here was a most hopeful prospect of early improvement, and the scope for it might be seen from the fact that in 1951 out of 1,400 tankers coming to or leaving United Kingdom ports only 140 discharged their oil washings into reception facilities at ports, while the other 1,260, or 90 per cent., just put them somewhere into the sea. Increasing coastal movements made the control of all coasting vessels important, including the smaller ones, but if deep sea tankers, i.e. ships of 2,500 gross tons or over, whether on deep sea voyages or on coastal voyages, were dealt with, a great step forward would have been taken. More than half this country's oil supplies was brought in foreign bottoms and he hoped that our oil companies would not hesitate to exert the power they had by chartering only from owners who agreed to adopt the best practice.

Dry cargo ships needed some form of separator on board to reduce the quantity of oil residue to be discharged ashore to manageable proportions and the committee recommended that such ships should be fitted with separators as the only practicable method of preventing pollution. This could not be universally insisted upon at once and, as an interim measure, the committee recommended that ships on the United Kingdom Register should, subject to certain exceptions, be prohibited from discharging oil within a wide zone of our coasts, which included the whole of the North Sea. Meanwhile, of course, the voluntary agreement as to a 50-mile limit would continue. Many miscellaneous recommendations, all of them valuable, would be found in the Report. Further research in various directions was required and the effect of oil upon marine life and fish food needed a good deal more study. The proposal that a code of conduct should be prepared for the guidance of those concerned was particularly valuable. They looked confidently for energetic action from the Minister. They should not contemplate weary years of international argument in the hope of securing complete agreement, or be content to refer the matter to some Intergovernmental Maritime Consultative Organisation yet to be created. The oil companies were few; the countries owning a large tonnage of tankers were not numerous, and their shipowners were well organised. There had been many encouraging signs of goodwill and good intentions on the part of British shipowners and any stimulus to rapid dealing with this intolerable nuisance was not attack upon them. Let them not timidly fix a date for achieving the ultimate policy too far ahead. Admittedly the problem had many sides and affected many interests, here and abroad. Progress would be anxiously expected, and if the Minister were to make his Committee a Standing Committee, with instructions to report annually upon the rate of progress, they would all feel better assured that something effective was happening.

Subsequent generations had been fond of abusing the nineteenth century and the mistakes of the industrial era in dealing with town and country. Why go on committing with far less excuse and with eyes wide open similar mistakes? We had polluted and were polluting the air by preventible discharge of dirt and concentrations of sulphur acids. We had turned too many of our rivers into sewers, in which fish could not live or plants grow. Let us remedy without delay the state of our beaches and of the surface of the sea, which not long ago seemed immune from human damage, now that the way to do so had been so clearly shown. If man made himself a nuisance to the rest of nature—of which, after all, he was part—and continued to befoul his natural surroundings, the consequences would come back upon man, upon his health and his pleasures, and would increasingly impair the best and surest means whereby he was able to sustain and recreate his physical and spiritual energies and well-being.

Mr. Donald F. Anderson, chairman of the General Council of British Shipping, said that the conference already knew the general attitude of British shipowners from the solid fact that they accepted the Report and recommendations of the Faulkner Committee and decided to put into practice some of the measures which were recommended for preventing pollution. British shipping was entirely unsubsidised and unprotected. Accordingly it had to be made to pay by its own efficiency, and two of the greatest factors in this fascinating but not easy competition were keeping expenditure down and keeping speed of turn-round up. There was no denying that the committee's long-term proposals would add to expenditure, and might reduce speed in turn-round. But in spite of that, few, if any, shipowners represented by the General Council of British Shipping would feel complacent if they knew that failure to do something which they could do to prevent oil pollution meant the destruction of sea birds, or that someone's enjoyment of a bathe or a walk along the seashore had been spoilt.

He did not propose to go into past history, which was all set out in the report of the Committee, but it was worth recalling, as Lord Hurcomb had done, the part played by British shipowners 30 years ago and since. There was no doubt that in recent years oil pollution of the sea had become more and more serious. British shipping as an industry appreciated this, and he had no hesitation in claiming that the work of the Faulkner Committee was made easier by the fact that the shipping industry already had an Oil Pollution Policy Committee in being. A good deal of technical study had already been undertaken, the result of which, with other information, was readily placed at the disposal of the Faulkner Committee.

He was not speaking for any particular section of the British shipping industry and he was not prepared to say whether the pollution from which this country had suffered was attributable mainly to dry-cargo ships or to tankers, to deep sea ships or to coasters, or to British ships or to ships of foreign flags. If he were to try to place the blame it could at best be only an expression of opinion since no means of proving anything was available. Moreover, it might well be that some of the pollution put down to ships came from other sources. For example, he understood that creosote—which was mentioned as a persistent oil in the Faulkner Report—was produced in a crude form in the manufacture of gas. Did they know—and if not, ought they not to find out—what happened to residual creosote produced in this way?

One of the valuable things about the Faulkner Report was that it was probably the most informative document on oil pollution that had so far been published. The reasons for pollution and the difficulties of preventing it were not subjects which lent themselves easily to simple explanation. Up till now there had been a tendency, which was understandable, for the uninformed to believe that oil got into the sea just as waste paper got into Hyde Park—because people could not be bothered to use a waste-paper basket. Thus it was easily supposed that dirty habits could be easily cured by fitting each ship with a separator, rather like fitting a silencer on the exhaust pipe of a car. Of course, the position in reality was very different. For some types of ships, mainly deep-sea dry-cargo and passenger vessels, a separator might well be part of the answer, and many such ships had for long used separators. Tankers, on the other hand, as the Report showed, were their own best separators and there would be no point in putting into a tanker a large and expensive item of equipment which would do no quicker, no better, and no more than what the tanker could do itself by the use of its various tanks.

Whatever method was used to separate oil from water in a ship, this was only the first stage. The next question was how to get rid of the resulting oily residue. It would be idle to deny that in the past that residue had usually gone into the sea, except where it was possible and economical to consume it on board the ship, or the quantities were so small that the residue could be kept on board and got rid of later in port. In the case of British ships, there were two reasons for this practice—a belief that the 50-mile limit from land gave sufficient protection; and the absence at many ports here and abroad of facilities to receive these oily residues except the small quantities that could be landed in some sort of container. The use of boiler oil for diesel ships had greatly added to this problem. What was to be done with the residue after purifying the heavy oil?

Oil Pollution of the Sea—continued

The information obtained by the Faulkner Committee suggested that so far as the United Kingdom, and for that matter the near-Continental and Scandinavian countries were concerned, observance of the 50-mile limit was not enough. The committee therefore recommended a prohibited zone, on a very much enlarged scale, which would have the effect of protecting the coastlines of these countries, at any rate, until there was a general prohibition against the discharge of persistent oils into the sea anywhere. The absence of reception facilities at the ports was no doubt to some extent due to the fact that, in the past, there had not been any great demand for them and, of course, they cost money, not only to provide, but to shift or make use of. But if ships had to fit separators and ships were to be made to " contain " themselves until they have reached port, then clearly reception facilities would have to be available at a great number of ports and this was a recommendation of the committee. Remembering the size and complexity of many ports, it would be no easy task to locate these facilities in the right place and to provide the means of getting either the ship or the residue to them. All this would take time and it would be some years before pollution ceased to be an anxiety to all of them.

It was curious how, in this country at any rate, the effect of oil pollution should be so much more a live subject than the effects of " smog " and the pollution of our own rivers. " Smog "—a mixture of smoke and fog in word as in fact—in London alone did incalculable damage to buildings and to clothes; last December it was responsible for the deaths of more than 1,000 inhabitants of Greater London. Pollution of our rivers by industrial and sewage effluents killed millions of fish yearly, apart from its damaging effect on property and plant life. A few yards from that hall flowed what the poet Edmund Spenser called the " sweet Thames." That was nearly 400 years ago; the river hardly earned that title now. Every form of filth went into it, and one of the major sufferers from this state of affairs was the shipowner, particularly from the effects of sulphuretted hydrogen produced by the discharge of sewage effluents. During the last three years, one passage up the river during the summer was enough at times to discolour the entire paintwork—exterior and interior—of his ship so badly that she had to be repainted throughout, and all the metal cleaned. The fouling of the atmosphere of our cities and the waters of our rivers seemed to have become an accepted part of the life of this island long before oil as a cargo or a commodity had any significance as a good or a bad thing in the industrial and domestic spheres in which it now played such a vital part. He mentioned this not as a complaint, but because there was this difference between pollution of the air and the rivers of a country on the one hand and the pollution of the sea on the other—that in the one case the remedy was a domestic matter in the hands of the country concerned, while in the other it could only be applied effectively by international goodwill and agreement.

That brought him to the position in which British shipowners found themselves to-day. Within a short time of the issue of the Faulkner Report, the Chamber of Shipping of the United Kingdom and the Liverpool Steam Ship Owners' Association sent to all their members, representing something approaching 17,000,000 tons of shipping on the United Kingdom Register, a recomendation that all owners, without waiting for legislation, should put into force those of the measure to prevent pollution mentioned in the Report of the committee which it was possible to adopt right away. In general terms this involved voluntary abstention from putting oil into the sea, in the case of some oily residues, by any ships anywhere; in the case of others, within the prohibited zone; while other distances were recommended according to circumstances. These were preventive measures which must be distinguished, of course, from the physical requirements with which the Report also dealt, the chief of which was the fitting of separators in some classes of ships. Here they did not feel that they could make any recommendation to their shipowners, because the requirements in the matter of separators had still to be defined. It was a growing practice to fit separators in deep-sea dry-cargo ships and the last inquiry made showed that at June 30, 1952, of the 1,322 oil-using deep-sea dry-cargo ships covered by the inquiry more than half were fitted with separators. It would be interesting to know how this compared with the position in other countries.

Shipowners were doing what they could to help in solving this problem but it would take more than action by British owners before there could be any really material improvement. Consider, for example, the vast amount of shipping of other flags which went up and down the English Channel without touching this country. Remember also that in 1952 there was probably as much crude oil imported into the near-Continental countries as the United Kingdom imported, and that more than half our total was brought in foreign tankers. Shipping was a highly competitive business and British owners assumed that no one either in this country or abroad wanted them to remain at a disadvantage with the shipowners of other countries by taking on obligations which their competitors could ignore. Moreover, the object of stopping oil pollution could not be achieved if British shipping alone were to adopt any code unless the same measures were observed by the ships of other flags, because so much of the traffic in these waters was non-British. He was not suggesting that this was what was going to happen because they knew, through the International Chamber of Shipping, that the committee's Report was being closely studied by shipowners of other countries who had been told of the action already taken by British owners. They hoped that the forthcoming meeting of the International Chamber would lead to the early adoption by non-British owners of the measures which shipowners in this country were observing.

However, goodwill among shipowners of the leading maritime countries was not enough. If the aim was to be reached of preventing oil getting into the sea anywhere this could only be achieved if vessels of all flags were bound by a Convention among all the nations owning ships. They had every confidence that the British Government would lose no time in bringing this matter before the Governments of other nations, but they did fear that there would be delays if it had to be dealt with by I.M.C.O., should that body be brought into being, or by the involved machinery of United Nations. The International Convention for the Safety of Life at Sea of 1948 was a good example of Governments getting together for a specific purpose and they urged that such a Convention should be called to deal with oil pollution as soon as possible. They might rest assured that British shipowners would do their best in this matter, in the future as in the past, to follow what he could claim on their behalf as their traditional policy, which was to reconcile their moral duties as citizens with their obligations as an industry, and to hold the balance fairly between the two.

Sir Douglas Ritchie said he spoke as chairman of the executive committee of the Dock and Harbour Authorities' Association, which comprised the principal ports of the country other than those owned by the British Transport Commission. Oil pollution was one of the early matters discussed by the Association upon its formation in 1920. The ports had always been fully alive to the harmful effects of oil pollution and not the least to its harmful effects upon the bird-life of our tidal rivers and estuaries. They hoped that with the passing of the Oil in Navigable Waters Act, 1922, there would be an end to the oil pollution of the waters which came under their jurisdiction, but unfortunately it had proved difficult to detect offenders against the provisions of that Act. Unless the escape or discharge of oil was actually seen coming from the ship it was often impossible thereafter to say which of the many ships had been responsible and the detection of offenders would involve port authorities in providing a large staff for this purpose, on duty at all hours, and this was obviously not a practical proposition. There was also the further fact that some part of the pollution of inland tidal waters was caused by oil discharged or escaping many miles away at sea and being carried to our coasts.

In the early stages, the Association had many discussions with other interested parties and, in an effort to help solve the problem, the larger ports agreed to provide barges for the collection of oily water and these were made available for the use of shipping at the ports concerned. Unfortunately, these facilities were not used to any real extent, with the result that except at the ship repair ports they were withdrawn, or not replaced when they became unfit for further service. It was true that at a number of ports facilities for the reception of oily residue were still in being, but that was principally because at those ports they were made use of by ships about to undergo repair or survey.

Oil Pollution of the Sea—continued

The Association welcomed the recommendations of the committee for the prohibition of the discharge of persistent oils into the sea, either altogether or, as immediate policy, within certain zones, and they had made it clear that they would be prepared to co-operate in providing or securing the provision of adequate reception facilities at the ports. If the Report of the committee was accepted, tankers would not present any serious problem to port authorities, as facilities were generally adequate at the oil refinery terminals, whilst at other loading terminals, including particularly those used by coastal tankers, facilities would be provided by the oil companies. The port authorities willingly accepted the recommendation that they should have power to co-ordinate the provision of comprehensive reception facilities in agreement with ship repairers and oil companies for tankers using their ports for loading or repair, and this was already being done in some of the major ports. As he had already indicated, there were barge facilities available at the present time at a number of repair ports and where these were not sufficient the Association hoped that the ship-repairers would themselves provide them, as the cleaning of the ship prior to repair must be an essential preliminary part of the repair service. The ports other than the repair ports would be mainly concerned with securing the provision of reception facilities for dry cargo ships, not about to undergo repair. There was no doubt that adequate facilities would have to be provided for these ships and it might well be that some facilities would be provided by port authorities and some by commercial oil recovery firms or from other sources.

It was early to say what form the facilities would take. That must depend to a very large extent on the conditions at the particular port, and the type of facilities provided to meet those conditions would no doubt vary from port to port. The facilities might be static or mobile, either barge or road vehicle, and in some ports it would probably be necessary to provide a combination of the two. In the large ports it might be that the facilities provided from various sources would have to be co-ordinated by the port authorities, who had agreed to undertake this responsibility.

The Association assumed that if the Report was accepted, legislation would be introduced to give effect to the recommendations. So far as port facilities were concerned, the Association had said that any such legislation would be acceptable to them if it empowered the Minister to require a port authority to provide the necessary facilities where, after holding a local inquiry, the Minister was of the opinion that the facilities provided at that port from all sources were not adequate. The Association had suggested that the matter should be dealt with in this way, not with any intention of avoiding their responsibility but because they felt that a general requirement to provide facilities, applicable throughout the country at all ports both large and small, would be difficult to frame as requirements must necessarily vary from port to port. They believed that the suggested procedure, whereby an inquiry might be held to decide whether the facilities at a particular port are adequate was a more practical way of dealing with the problem.

There were two other matters to which he should draw their attention. The ports had felt for some time that the provisions of the Oil in Navigable Waters Act, 1922, should be strengthened in certain respects and they had recently made representations to the Minister for the amendment of that Act in the following terms:—

(i) The Act should require the master of a vessel, from which oil was leaking, on entering a harbour to report the fact to the harbour authority with a statement of the cause of leakage.

(ii) The Act should also provide that the master of a vessel from which oil had escaped or the person having charge of apparatus from which oil has escaped should be bound to report the fact to the harbour authority.

(iii) The Act should apply to all vessels and the section which provides that the Act shall apply to any vessel which was capable of carrying oil in bulk, whether for cargo or for bunker purposes, more than 25 tons of oil, or which, though not so capable was constructed or fitted to carry in bulk more than five tons of oil in any one space or container, should be repealed.

(iv) If the limitation in subsection (2) of section 8 was to be retained, the subsection ought to be amended so as to be negative in form instead of positive, as at present the burden was on the prosecution to prove affirmatively as a fact that the vessel was one within the description contained in the subsection; whereas, if the subsection were made negative in form, the provisions of paragraph (2) of section 39 of the Summary Jurisdiction Act, 1879, would apply and it would be for the defence to prove that the vessel was within the exception, where they intended to rely on that fact.

(v) Section 1 (1) of the Act provided that " the owner or master of the vessel shall be guilty of an offence." If it was the intention that both were to be guilty of an offence, then it was suggested that the word "or" should be replaced by "and" (cf.s.7 (2)) of the Petroleum (Consolidation Act, 1928) and that provision should be made, if need be, that the conviction of one should be a bar to proceedings against the other.

The Association hoped that these recommendations would be accepted, the Act would be strengthened and that as a result very little, if any, oil from ships would find its way into the docks or the tidal waters under the jurisdiction of the dock or harbour authority. There was the further problem of sources of pollution other than ships. The Association were fully alive to this problem and they hoped that the strengthening of the Act of 1922 and the new legislation would result in an improvement. He could promise on their behalf that they would do all they could to secure that, where this pollution existed, it should be stopped.

Captain W. T. Coombs, president of the Officers' (Merchant Navy) Federation, said that masters and officers were in complete agreement with the views expressed by the owners; at the same time he did not want to see British shipping unduly handicapped with regard to foreign ships who were not following the action taken by British shipping.

Speakers from Scandinavian countries expressed their satisfaction at the announcement of the Minister of Transport regarding the proposed conference.

Dr. H. R. Lillie, a former surgeon to one of the Antarctic whaling fleets, said that whatever legislation was introduced internationally he hoped it would cover the operations of the whaling industry in the Antarctic and other seas. There were in the industry companies that were exemplary in this oil question, but there were those whose behaviour was quite the opposite.

The Conference was concluded by adopting the following **Declaration of Aims:—**

1.—This Conference expresses its emphatic support of the view that ships of all nations should be required to refrain from discharging persistent oils into the sea, as this is the only effective means of ending an intolerable nuisance.

2.—This Conference notes with satisfaction the readiness of the British Shipping Industry to adopt partial remedies which will lessen the evil without waiting for agreed action by shipowners in other countries. This Conference also welcomes the expressed willingness of the main oil companies to provide or co-operate in the provision of facilities for handling waste oil at oil loading ports under their control abroad.

3.—This Conference recognises that the full practicable measure of success in preventing oil pollution cannot be secured without international agreement. Its members will use their best efforts to stimulate opinion in all countries so that effective international action can be taken. To this end, the Co-ordinating Advisory Committee on Oil Pollution of the Sea will invite representatives from other nations to take part in their discussions and widen their acivities as necessary in order to be in a position to undertake international propaganda.

4.—This Conference urges that, in accordance with the recent report to the Minister of Transport, statutory provision should be made to ensure that adequate facilities for the reception of oily residues are available at ports in the United Kingdom and at oil loading terminals and repair yards.

5.—This Conference welcomes the announcement by the Minister of Transport that the Government of the United Kingdom has decided to take the initiative in calling together the principal maritime nations for the purpose of considering the best means of preventing oil pollution and with a view to drawing up an international convention for ratification by the nations principally concerned, and urges that pending the signature of such convention, all possible steps, by legislation and otherwise, should be taken by individual countries to control the situation.

Coastal Protection

Review of Methods for Defence

By PER BRUUN
Technical University of Denmark.

There are four different types of coastal protection.

Groynes, which are built perpendicular to, or at an inclination with, the shoreline,

Sea Walls, which are constructed parallel to the shoreline. On exposed shores both sea walls and groynes are sometimes constructed.

Breakwaters, which are situated at some distance from the shoreline.

Artificial Nourishment of Beaches, material eroded from the beach being replaced artificially by sand material.

All coastal protection problems are closely connected with littoral drift problems, because, as a rule, it can be taken for granted that protection of a coast is only necessary where the erosion exceeds the supply of material.

It will therefore be of interest first to consider the littoral drift problems.

THE LITTORAL DRIFT

Littoral drift problems command a wide interest, viz. for the control of floods, reclamation, construction of harbours and coastal protection works.

As pointed out by H. A. Einstein in (1), there cannot physically be much difference between the transport of sediment in rivers and the drift along sea shores, apart from the littoral zone with its extremely complex conditions.

The sediment transport problem in rivers is investigated by Shields, Kalinske and Meyer Peter (2) p. 795/799 and, especially, by Einstein, whose theories have given reliable results in practice, see (3).

To-day it is not possible to deal rationally with the littoral drift problem on sea shores. Until now the practice has been adopted of splitting up the complex problem into single problems, and investigating these separately. This work has hitherto given several results of practical interest for the littoral drift, and coastal protection technology. This especially holds good of the investigations of the so-called equilibrium profiles, see below.

Material drifts in two ways, partly as bed-load transportation and partly as suspended-load transportation. Bed-load transportation starts because the movement of water over the bed of the river or the sea exerts a sheer stress upon surface particles of the bottom. When the force exceeds the resistance of the particle to movement, transport will begin. In suspended-load transportation the finer material moves in suspension because the turbulence prevents the particles from settling. Coarser material moves along the bottom in the way that the individual grains are continuously replaced by particles of the same size in the bottom layer.

In order to understand the littoral drift problem on sea shores it will be of interest to consider the so-called equilibrium beach profiles.

Equilibrium Beach Profiles.
Definition:

Laboratory. An equilibrium beach profile is a beach profile which maintains its form. The initial condition is a vertical wall.

Actual. An equilibrium beach profile is a statistical average profile which maintains its form, apart from smaller fluctuations including seasonal fluctuations. One must distinguish between a summer profile and a winter profile.

Types of Actual Beach Profiles.

The form of the actual beach profile depends on such factors as the wave characteristics and their mutual ratios, the direction of wave propagation, and the change in wave action. Different waves, for instance, try to destroy the system of bars not belonging to their peculiar profile and build up a new system of bars. Besides it must be assumed that the profile is a function of the grain size, grain size distribution, and specific weight. Where bed rock exists, bars cannot be formed. Besides the coastal currents, especially the longshore current due to the wave breaking may play a role.

Fig. 1. Map of Denmark.

Ultimately, the form depends on the initial conditions. On very steep coasts a single bar may appear, or perhaps none at all. It seems as if the number of bars depends on the magnitude of littoral drift. When the drift increases, the possibility of formation of bars will also increase, but it cannot be maintained that a profile with, for instance, three bars carries more material than a profile with only one bar, because many other factors may influence the magnitude of littoral drift.

Considerations on the basis of the development of beach profiles on the Danish North Sea coast, which is built up of sand grains between 0.2 mm. and 0.3 mm., seem to show that one can distinguish between profiles in another way, i.e. between the over-nourished, the sufficiently nourished and the under-nourished profiles.

The over-nourished profiles are fed with more material than the waves can shape into a beach profile. These, therefore, are irregular and often perform as shoals. On the Danish North Sea coast we have some examples of such profiles in the extreme areas at the Skaw to the North and at the Blaavands Huk to the South (see Fig. 1). In both cases the littoral drift is at the maximum, and accumulations take place irregularly (see 4).

There are two different types of sufficiently nourished profiles. In one of them the profiles are not fed with more material than the waves can shape into a profile, which still has the same "equilibrium form."

Coastal Protection—continued

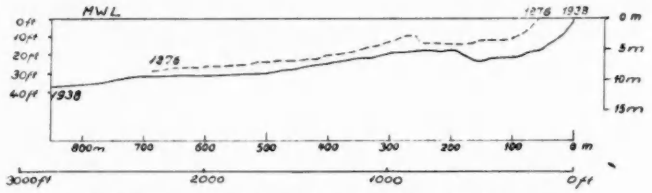


Fig. 2. Beach profiles at Lyngby, the North Sea coast.

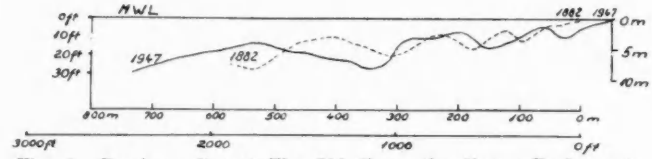


Fig. 3. Beach profiles at The Old Skaw, the Skager Rack coast.

In the other the loss of material equals the supply of material and the profile has still the same equilibrium form. The beach profiles off the Ringkoebing Inlet Barrier on the Danish North Sea coast, see Fig. 1, are probably of that kind.

The under-nourished beach profiles are eroded, i.e. the coastline retrogrades. Profiles of that kind are found between Lodbjaerg and Noerre Lyngvig on the Danish North Sea coast. The under-nourished beach profiles will always keep an equilibrium form, but the form may change from one locality to another, depending on the conditions in general, as mentioned above.

Fig. 2 shows a beach profile at Lyngby (see Fig. 1) on the Danish North Sea coast in 1876 and 1938. The profile, which is under-nourished in a minor degree, has only one bar and is situated close to the nodal point for the nearshore littoral drift on the North Sea coast, which seems to be the coastal area between Lodbjaerg and Lyngby (see Fig. 1), (4) and (5). Fig. 3 shows the beach profile at The Old Skaw at the northernmost part of the North Sea coast. This profile is under-nourished, the retrogradation of the shoreline being about 3-ft. a year, but the littoral drift is very considerable.

From what is mentioned above, it seems quite clear that progradation of a coast may take place with or without equilibrium profiles, while retrogradation of a coastline can probably only take place with equilibrium profiles having a maximum steepness corresponding to the quantity of littoral drift. This is the case on the Danish North Sea coast. An actual equilibrium profile, therefore, should be defined as a stable profile with maximum steepness (apart from fluctuations of the profile from one period to another).

Investigations on Equilibrium Profiles in the Laboratory.

The laboratory experiments showed that (see Fig. 4), (6), (7), (8), and especially (9), Saville:

(a) Waves with a high steepness ratio, for instance

$$\frac{Ho}{Lo} = 0.043$$

(Ho = the deepwater wave height; Lo = the deepwater wave length) will make a bar profile, see Fig. 4B, b. Waves with a low steepness ratio, for instance

$$\frac{Ho}{Lo} = 0.018$$

will make a beach ridge profile, see Fig. 4C, c and D, d (experiments in Copenhagen).

(b) Waves with a high steepness ratio will erode the beach; waves with a low steepness ratio will build up the beach.

(c) Waves with a high steepness ratio can be identified as winter waves. They form a storm or winter profile. Waves with a low steepness ratio can be identified as summer waves. They build up a swell or summer profile. The intermediate profile occurs at a steepness ratio of about

$$\frac{Ho}{Lo} = 0.026, \text{ see Fig. 4E, e.}$$

(d) There were two types of littoral drift, bed-load transportation on the beach itself (beach drift) due to uprush and backrush, and suspended-load transportation in the breaker zone due to the breaking waves and the generated longshore currents.

(e) In equilibrium storm profiles, the transportation was produced mainly as material in suspension by the longshore current. In equilibrium swell profiles the transportation mainly took place as beach drift. The transition between these different types of transportation was sudden and occurred at a steepness ratio of about 0.03.

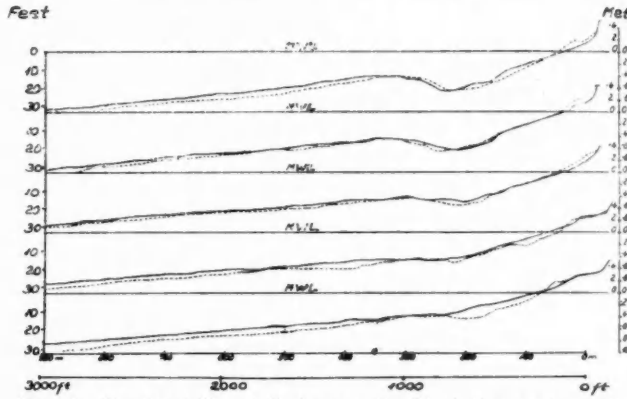


Fig. 5. Beach profiles at Borbjaerg, the North Sea coast, seasonal fluctuations.

(f) The transport along summer profiles was much greater than that along winter profiles for waves with the same energy content. The peak transport occurred at a steepness ratio of from 0.02 to 0.025, and is almost entirely beach drift.

(g) The transport rate decreased very rapidly for steepness ratios less than 0.02.

(h) The transport rate increased with an increase in wave energy; other conditions remaining the same.

(i) The transport occurred almost entirely in the area shoreward from the breaker.

Investigations with Actual Beach Profiles.

Investigations carried out in the United States and in Denmark, see (4) and (10).

Fig. 5 shows five profiles sounded at about 330-ft. (100m.) apart on the Danish North Sea coast—South of Bovbjaegr (Fig. 1), where the spot is indicated by cross hatching. At the same time levels were taken of the beach itself. The soundings were carried through to 30-ft. depth, about 3,300-ft. from the shoreline. For the wind and wave conditions in the North Sea, see (4) and (5).

The dotted lines show the profiles on the 15th of November, 1951. The profiles are summer profiles with " beach ridges " on the beach itself. It will be seen that the bar has migrated towards the shoreline, but the bar is still there and indicates the tendency of the summer waves to carry material from the bar to the beach. The profiles existing during the soundings on the 23rd of January, 1952,

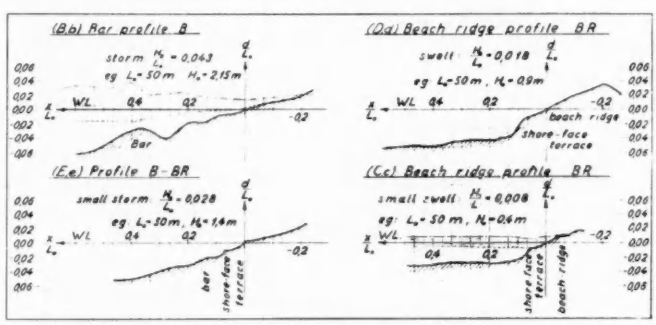

(Bb) Bar profile B
storm $\frac{H_o}{L_o}$ = 0.043
eg L_o = 50 m H_o = 2.15 m
WL
Bar
(Da) Beach ridge profile BR
swell $\frac{H_o}{L_o}$ = 0.018
eg L_o = 50 m, H_o = 0.9 m
beach ridge
shore-face terrace
(Ee) Profile B-BR
small storm $\frac{H_o}{L_o}$ = 0.028
eg L_o = 50 m, H_o = 1.4 m
bar
shore face terrace
(Cc) Beach ridge profile BR
small swell $\frac{H_o}{L_o}$ = 0.008
eg L_o = 50 m, H_o = 0.4 m
shore face terrace
beach ridge

Fig. 4. Equilibrium beach profiles, laboratory experiments.

Coastal Protection—continued

are shown in full lines. Several severe gales appeared between the sounding in November and that in January. It can be seen that the difference between the summer profile and the winter profile consists in the summer profile having a beach ridge steeper than the winter profile.

Meanwhile, there is no balance between the quantities eroded from the beach and those deposited on the sea bottom, and the accumulation in the outer sections of the beach profiles is probably caused by supply of sand from the bottom outside the 30-ft. depth contour. Further, it looks as if this material migrates on the bottom along the shore in great humps.

The appreciation of the development of beach profiles and the littoral drift along these profiles is very important for an understanding of the way in which coastal protection becomes effective.

GROYNES

R. O. Eaton, chief, Beach Erosion Board, Washington, D.C., in his paper to the First Conference on Coastal Engineering (11), names a group of groynes as a " man-made littoral barrier," i.e. a barrier which prevents the natural littoral drift.

The ability of a groyne to collect material depends on the grain size of the material, the shape of the beach profile, the types of waves, and the intensity of the littoral drift. As a general rule, groynes should never be used where there is no littoral drift.

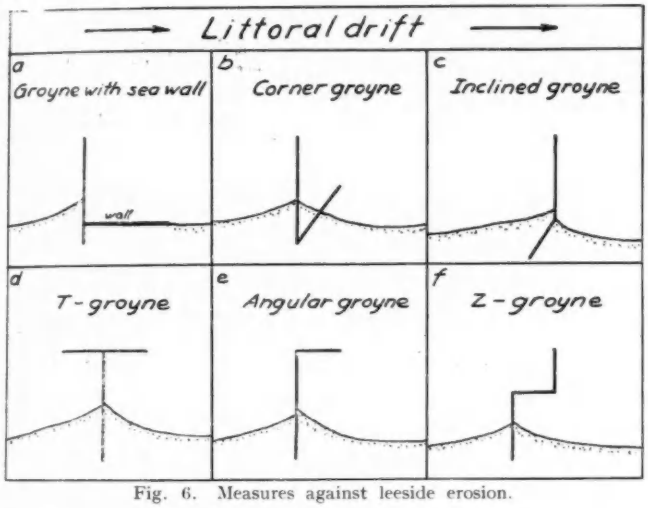


Fig. 6. Measures against leeside erosion.

As described above, the fine material (grain size less than 0.15 mm.) mainly migrates in suspension and settles only when motion of the water is very slow or has stopped. This means that there is not much chance of accumulation of fine material along a groyne, whereas coarser material, such as shingle, moves over the bed, for which reason it is of great value as beach protecting material. If the migrating material consists of sand the groynes will produce a selection of material, by which especially the coarse grains are accumulated on the updrift side of the groyne, see (11).

The shape of the beach profile is also very important for the ability of a groyne to accumulate material. If there are no bars a very essential part of the littoral drift will take place on the beach, which means that in most cases groynes will work well if sufficient material is available. On the other hand, the beach will often not be very stable, compare the conditions on the English Channel coasts' " shingle beaches."

If there are one or more bars, littoral drift will take place on and between the bars. It looks as if the number of bars increases with the intensity of the littoral drift, but it is no indication of the quantity of littoral drift. This means that a group of groynes may work well even if there are several bars, but there is probably a better chance of a good result when there is one bar only or none at all.

Still, what is said above regarding the influence of the different types of waves on the beach profile and on the littoral drift will have to be considered. When groynes accumulate material in summer it must be due to the influence of swells which have a pronounced beach transportation.

Fig. 7. Corner groyne at Maersk, the North Sea coast.

Finally, the intensity of littoral drift must play a role because the stronger the littoral drift, the faster will a group of groynes accumulate material.

Meanwhile the serious drawback of any group of groynes or any jetty is that they act as a littoral barrier, which means that they push the migrating material from the updrift side out into deeper water, where it is possibly lost for the coast or, in any circumstances, is only carried ashore again at a greater distance from the groynes.

Measures Against Leeside Erosion.

In many cases it would probably have been better if groynes had never been constructed, because they have done much more harm than good.

Measures against leeside erosion can be divided into those with (a) Short-range influence and those with (b) long-range influence.

(a) **Short-Range Influence.**

The measures are, see (4):—

(1) **A Sea Wall on the Leeside,** see Fig. 6a. This measure is the most primitive one, but is often used, and it is effective when the coast recession is not so strong that the shoreline becomes eroded rapidly at the end of the sea wall.

(2) **Corner Groynes,** see Fig. 6b and Fig 7 from the Danish North Sea coast. The corner groynes prevent the erosion from running in directly along the main groyne. It is an expensive method, however, and the effect is limited to a very small area.

(3) **Inclined Groynes,** see Fig. 6c and Fig. 8, which show the groyne-group at The Old Skaw at the northernmost spit of Denmark, Fig. 1. The groynes are constructed with slanting land-ends, particularly advantageous at the last groyne in the group, because when it is so built, the erosion on the leeside does not run close to the stem of the land-end.

(4) **T-Groynes,** see Fig. 6d. In his report to the XVIIth International Navigation Congress in 1949, Col. Frech writes about the T-groyne, built at Asbury Park, New Jersey, as follows, see (12) p. 52: " Several of these groynes have been experimentally supplemented by breakwater members extending 100 to 150-ft. at right angles, at their outer ends forming a T. It is too early to judge the results produced by these structures, but the following observation may be made: Certainly, further erosion of the bluff has been stopped, the groynes not having the breakwater feature at

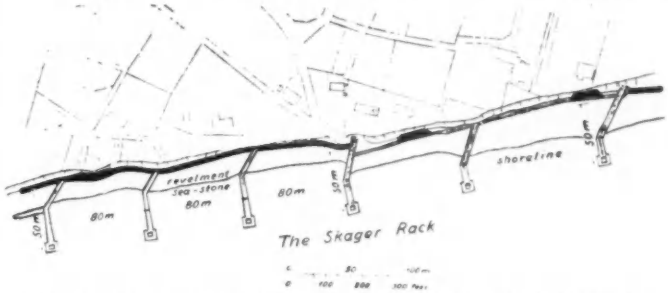


Fig. 8. Groynes with slanting lands-ends at The Old Skaw, the Skager Rack coast.

Coastal Protection—continued

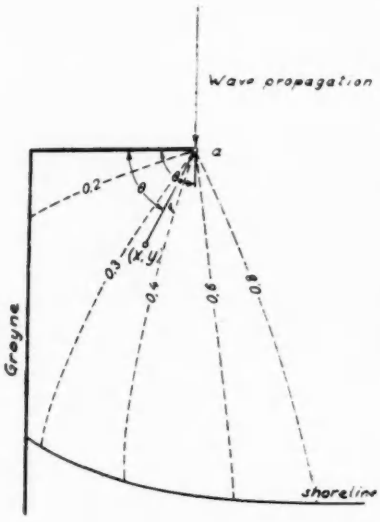


Fig. 9 (left). Angular groyne diffraction diagram.

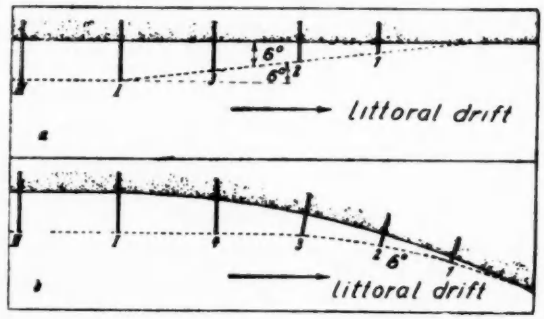


Fig. 10 (above). The principal of shortening by Kressner.

their outer ends have not accumulated much sand, if any, but those with the breakwater addition (known now as T-groynes) have had a paradoxical effect, sand having accumulated along both sides of the stem of the T, but with deposits on the down-drift side exceeding considerably the accumulations on the up-drift side."

The T-groyne has, however, been used before; Matthews wrote in 1934, see (13) p. 218: " If, on the other hand, there is sufficient travel of material, the protection of the coast can be assured by groynes alone. If the supply is insufficient, or there is a reason to fear that storm-waves may strike the coast in a direction parallel with that of the groynes, so producing an excessive thinning of the beach, the protective works should comprise, in addition to groynes, a longitudinal structure. Special types of groynes, in a bent line, T-shaped or cruciform, designed for this purpose, have not yet received the sanction of experience."

The successful effect of the T-groyne is explained by the theory of the Angular groyne.

(5) **Angular Groynes,** see Fig. 6e, and Figs. 9 and 11. The wave propagation is as in the figure. A cylinder-wave is caused by diffraction at the corner a. In the figure, lines are drawn through points with the same diffraction-coefficient, provided there is a constant depth behind the angle, complete absorption at the stem of the groyne (length 2L, L = the wave length) and no friction loss at the bottom.

As a consequence of the diffraction a littoral drift is produced from the leeside, towards the groyne. At the same time the steepness ratio of the waves is reduced behind the angle. The reduction is considerable, and, consequently, the waves will change quickly into a constructive type, see Fig. 4. Laboratory experiments verified the theory.

Fig. 10 shows an angular groyne constructed at Bellevue beach north of Copenhagen. The first test groyne in the field was constructed by the Board of Marine Works in the Nissum Inlet.

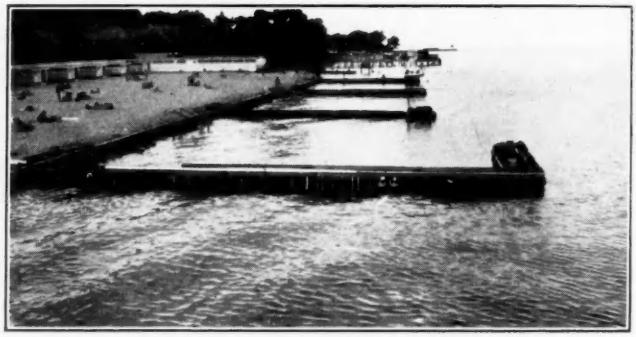


Fig. 11. Angular groyne at Bellevue, Copenhagen.

(6) **Z-groynes,** see Fig. 6f. It has all the properties of the Angular groyne and accumulates material on the leeside. In laboratory experiments the Z-groyne was made uneven by the use of piles. Part of the wave-energy running along the groyne was destroyed, which tends to the possibility of deposits along the stem of the groyne. It seems to the author that an ideal group of groynes is obtained when Z-groynes are used on the principle of shortening (see below). The coast is in this way divided into small headlands, see (14).

(b) Long-Range Influence.

(1) **The Principle of Shortening.** Fig. 10 illustrates the principle of shortening of Kressner, see (15). Kressner's laboratory experiments and practical experience in Holland (14, etc.) are in favour of the use of groups of groynes, the groynes on the leeside being shortened at a very small angle, 4—6 degrees.

(2) **The Sand-Diverting Fence of Spaced Piles.** This principle has so far not been tried out in practice.

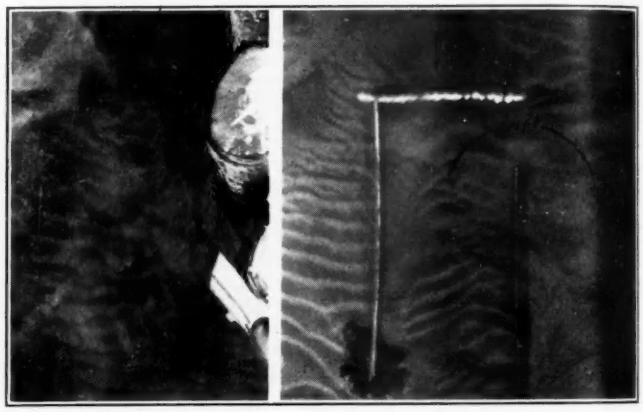


Fig. 12 (left). Asymmetrical ripple marks. Fig. 13 (right). Laboratory experiments. University of California.

As mentioned above, experiments in the laboratory and field tests have proved that waves with a high steepness ratio erode the beach, while waves with a low ratio build up beach. In the laboratory it looks as if, in shallow water, waves with a low steepness ratio will create very asymmetrical ripple marks at the bottom with the steep slope inward, i.e. the material drifts shoreward. In the case of waves with a high steepness ratio, material also drifts shoreward but, as far as can be seen, not to the same extent, and the water thrown in by the wave-breaking causes much undertow (and rip-current) with the result that much material is carried out from the shore again.

Fig. 10 shows the angular groyne constructed at Bellevue north of Copenhagen. Fig. 12 is a photograph of the bottom inside the angle where waves with a low steepness ratio occur. From shadows at the bottom it will be seen that the ripple marks are asymmetrical. The steep slope is inward, i.e. the material drifts shoreward. Fig. 13 shows a result of laboratory experiments made at the University of California. The direction of wave propagation is as indicated. The waves with steepness ratio

$$\frac{Ho}{Lo} = 0.045$$

produced symmetrical ripple marks in the open sea but very asymmetrical ripple marks behind the spaced piles, where material drifted shoreward.

Fig. 14. The sand-diverting fence of spaced piles.

Coastal Protection—continued

On the basis of the above there is reason to believe that by an arrangement as shown in Fig. 14 it is possible to bring back to the beach bed-load transported material which the groynes pushed out into deeper water, with the result that it was lost to the beach. It is to be hoped that the construction will have a similar influence on the material transported in suspension. The fence should be constructed so that the space between the piles can be gradually adjusted according to experience. The steepness ratio of the waves behind the fence should probably be 0.01—0.02. Attention must be paid to the scour of the bottom at the inner end of the solid wall.

SEA WALLS

Sea walls are used alone or in connection with groynes. As the function of a sea wall is exclusively of a defensive nature, the pure sea wall construction is mainly used where there is no littoral drift and, consequently, no possibility of building and maintaining a beach by means of groynes. Sea walls in connection with groynes are used for protection of valuable areas and buildings, chiefly at places where either the littoral drift is small or where the beach is maintained by artificial replenishment of sand. Sea walls with or without groynes are constructed on the same principles, but as a rule the strongest types are used in the latter case.

Fig. 15. Sea wall at Bridlington, South Yorks.

Fig. 16. Wooden sheet piling at The Skaw, Denmark.

The following deals with a problem of great importance to the construction of a good sea wall, namely, the energy - absorbing ability.

Different Types of Sea Walls.

The following four main types are in common use:

(1) Vertical walls.

These are built only where valuable areas must be protected. Some of the biggest and most well-constructed walls are found in England. Fig. 15 shows a photograph of the Beaconsfield sea wall at Bridlington, South Yorks, England. The wall is described by Matthews in (13) pp. 47—48. In his book, Matthews gives a detailed description of sea walls with special reference to conditions in England.

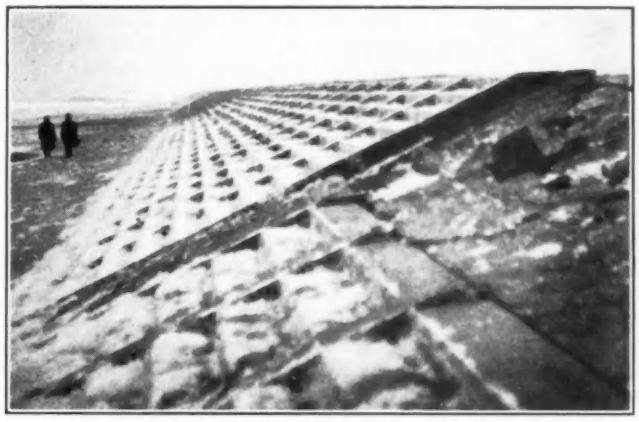


Fig. 17. Sloping wall at Lodbjaerg, the North Sea coast.

Most sea walls are impermeable, but permeable types are also found in the so-called " stone cribs," i.e. wooden boxes filled with stones. However, stone cribs have not been very successful, as they are not durable, cf. (16) p. 165 and (17).

(2) Sheet pilings.

Sheet pilings serve the same purpose as sea walls. They are generally used where the wave-attack is not very strong and often with a rubble mound in front. Fig. 16 shows a wooden sheet piling constructed east of the harbour of the Skaw, Denmark.

(3) Sloping walls or revetments.

Sloping walls may be impermeable or permeable. They must solve the same problem as sea walls and sheet pilings; but in most cases they do so in a more rational way.

Impermeable sloping walls are generally used in Holland, and probably were developed to protect the feet of dykes in an economical and effective way. The stepped walls are of Dutch origin. The technique is highly developed cf. for instance the walls in North-Holland, the Zuidersea-dam, etc., and it is still being developed, cf. (18) and (19). Also in England remarkable new constructions have been built cf. (20). Fig. 17 shows a photograph of a stepped revetment of reinforced concrete, built at Lodbjaerg, the Danish North Sea coast, see Fig. 1. The revetment has now been damaged in consequence of continuous erosion cf. (5). The sloping wall at Pett Level west of Dungeness, England, cf. (20) pp. 78—79 (Rother and Jury's Gut Catchment Board) consists of two slopes of concrete blocks, enclosing an inclined berm, 7.5 m. wide, covered with sheet asphalt. The joints between the blocks are filled with bitumen. In Holland as well as in England opinion differs as regards the necessity of using bitumen for filling the joints. At the new sloping wall at Scrapsgate, Thames Estuary (Kent River Board) heavy concrete blocks which could not be raised as an independent unit because of the interlocking with the adjacent blocks, have been used. This wall is, like the wall at Pett Level, equipped with a berm, in this case built of concrete blocks. At the remarkable wall at Dym-

Fig. 18. Stone-glacis at The Skaw, Denmark.

Coastal Protection—continued

church, west of Dungeness (Kent River Board) the design of the wall is in the main such that even if it is under-scoured the main structure will stand as it is, supported on piles with the facing designed as a beam of reinforced concrete cf. (20) p. 80. The sloping walls at Pett Level and Dymchurch are segregated by cross-walls, to prevent any damage to the facing extending into adjacent sections of the wall.

Permeable sloping walls appear in rubble mounds and in rough stone-glacis. Fig. 18 shows a stone-glacis with a wooden sheet piling and a rubble mound at the Skaw, the northernmost spit of Denmark.

(4) Wave screens.

Wave screens consist of spaced piles of wood or reinforced concrete rammed into the beach (England) or put in a sloping wall (Holland). Fig. 19 shows a wave screen at Pett Level (Rother and Jury's Gut Catchment Board) consisting of wooden piles. The wave screen is designed to break the waves and reduce the uprush, cf. (21) and (22). Similar structures were used in Italy already in the 17th century, cf. (23) p. 113.

(to be continued)

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Dundee Dock Reclamation.

The reclaiming of the remainder of King William IV Dock, the oldest link in the Dundee dock system, has been approved in principle by the Harbour Trustees. Powers to close the 6¼ acre dock were obtained in 1933, and the westmost section covering about two acres were reclaimed shortly afterwards. This reclamation will also mean the closing of the west graving dock, which, though uneconomic for commercial purposes, proved useful during the last war for the repair of small submarines and trawlers.

Book Review

"Earth Pressure Calculation." By Jorgen Brinch Hansen. Danish Technical Press, Engineering House, Copenhagen. 31s. (Great Britain) or 4.30 dollars (U.S.A.).

Since the first records of research on lateral earth pressure—those of Bélidor, followed in 1776 by the publication of Coulomb's work—continued research, particularly the most recent in soil mechanics, and notably the work of Terzaghi, has shown that the earlier theories of the behaviour of soils under stress and the implications of those theories on lateral earth pressure, while substantially valid, have their limitations.

It was between the years of 1908 and 1940 that foundation engineering was placed upon a more realistic and scientific basis. Nevertheless much still remains to be done in the field and laboratory in respect of the behaviour of soils under various conditions and as to the revolution of research results into mathematical methods of calculation that can be applied confidently to the design of foundations and earth retaining structures.

To civil engineers conversant with the design of such works it is a well-known fact that although the theories of Coulomb and Rankine produce satisfactory results in the design of ordinary retaining walls under certain conditions, they fail to do so in cases of flexible sheet pile walls, braced walls, etc., mainly because the possible movements of such structures are not compatible with the possible deformations of the earth, corresponding to the simple figures of rupture considered in Coulomb's theory.

There was therefore an urgent need for a more general earth pressure theory, capable of determining the earth pressures as functions of the movements of walls, both solid and flexible, so that the proper non-hydrostatic distributions might be found. As a result the experimental work of recent authoritative research workers in this field has done much to shed new light upon the subject.

The most recent contribution is that of Jorgen Brinch Hansen, the writer of the book, "Earth Pressure Calculation," which has been published recently. The purpose of this work is to introduce a new general earth pressure theory and completely new design methods for the calculation of earth pressures adaptable to the design of such structures as retaining walls, anchor slabs, face, fixed and anchored sheet pile walls, braced walls, double sheet walls and cellular cofferdams.

The author's new methods are applicable to cohesionless materials (sand) and frictionless soils (clays). It must be admitted, however, that earth pressure calculation has not been made simpler by the author's methods, but this is the price one has to pay normally for greater accuracy. However, a number of earth pressure tables and grabs are given in the appendix of the book for the assistance of the designer in his practical calculations.

The work contains a short description of the known methods of earth pressure calculation, the principles of the author's new general calculation method as well as a number of applications to practical earth pressure and stability problems, with numerical examples.

The fundamental basis of the new method is a connection, established by the author, between two known methods which he terms the extreme-method and the equilibrium-method. He overcomes many difficulties by proving that the two methods will give identical results, when a logarithmic spiral is used as a rupture line in both, and when a certain boundary condition is used in the equilibrium-method.

In order to study the shape of actual rupture-figures in sand, the author carried out a number of small-scale model tests in an apparatus devised for the purpose. The mathematical consideration of the many, simple and complicated, types of rupture dealt with is described with commendable clarity and accompanied by appropriate diagrams and excellent photographs of the actual rupture-figures obtained in the tests.

To the student of earth pressure theories this book provides, besides a clear exposition of the classical theories and methods of calculation, some completely new material and information. While the book should be studied by designers of earth retaining structures to whom it should prove to be a valuable aid, it is, at the same time, well to remember that sound engineering judgment is still the basis upon which the final solution and decision of complicated soil and design problems must rest.

H. F. C.

Manufacturers' Announcements

Intercommunication Equipment for Divers

Considerable improvements have been made in the efficiency of divers' intercommunication equipment as a result of collaboration between C. E. Heinke & Co. Ltd., submarine engineers, of Grange Road, Bermondsey, S.E.1 and The General Electric Co. Ltd., Kingsway, London, W.C.2. The new equipment enables divers to keep in touch with each other and with the diving party on the surface, and is a development of the Diverphone equipments used since the war by the Admiralty diving and research units and by H.M.S. "Reclaim"; also by the Norwegian, Polish and French Navies and by civilian divers in European and Indian waters.

It differs from the original Diverphone in so much as the H.T. supply, previously obtained from a motor generator in the back of the surface unit, is now provided by a vibrator. The circuitry has been overhauled, Osram miniature valves have been introduced into the amplifier circuit for compactness, and the construction is now on the unit principle to simplify servicing. These improvements result in louder surface signals, with less servicing and battery consumption. A further innovation has been the substitution of a head-operated transceiver (a speak-listen transducer and switch unit in the diver's helmet for transceivers of the earlier chin-operated type.

In the new intercommunication equipment the life-line, incorporating the wire lead for the transceiver in the diver's helmet, is clearly visible in this picture.

With this new equipment the merest whisper in the diver's helmet is audible to all on deck. However as is only to be expected, there were technical difficulties to be overcome, due to greatly improved sensitivity. Mechanical vibrator hum must not be transmitted through the chassis and metal case of the diving set, and air vibration affecting the relatively larger speaker cone had to be eliminated. Otherwise divers would hear a continuous "background" hum whenever the surface attendant spoke to them.

Another troublesome problem was that of hum in the vibrator pack. It was solved by the production of a special low-loss transformer, and by replacing with copper and brass as much of the steel as possible in the chassis, frame and case. Special attention was given to component layout, and the resilient mounting of the vibrator unit in a sponge-rubber tube, held away from the chassis by a moderately flexible metal stay helped to overcome the difficulty.

Risk of damage due to inadvertent reversal of polarity at the accumulator was obviated by a circuit design which embodies a cut-out incorporating a selenium rectifier and relay to isolate the circuit. This is a very sensitive safety system, making and breaking on a one-volt change with correct polarity and breaking at 50 per cent. normal voltage with reversed polarity.

Because the air pressure under which a diver works affects the pitch of his voice, which rises as the pressure rises, it became progressively more difficult in the older system for his signal to overcome the perpetual air delivery noises into his helmet. Frequency response has therefore been so controlled in the new equipment that inteference noises are reduced to the absolute minimum.

New Loader for Restricted Space

The Muir-Hill LH-1 Loader, manufactured by E. Boydell and Co. Ltd., of Old Trafford, Manchester, is claimed by its makers to offer the benefits of a mobile hydraulic bulk materials loader under confined working conditions. Thus it is useful where limitations of space, particularly headroom, has previously prevented any alternative to hand labour, as for example in ships' holds for trimming of bulk cargoes and for clearing 'tween decks and around stanchions. This loader has hitherto only been available to the home market, but is now being offered to overseas buyers. It is backed by their service and spares organisation.

The makers have produced a machine weighing under 2 tons, yet which they claim is capable of high rates of loading comparable with normal size mobile loaders. This is achieved by ease of control, general manœuvrability of the machine, and speed of operation, which combine to offset its smaller size. The loader requires a minimum of 6-ft. 6-in. headroom, has a wheelbase of 4-ft. ½-in., a track of 3-ft. 7-in. and a turning circle of 7-ft. 6-in. radius. These leading dimensions enable the machine to operate practically wherever a labourer can swing a shovel. On the other hand, it has a maximum under-bucket clearance of 6-ft. 6-in. which enables it to load into hoppers, bunkers, skips and all but the largest road vehicles.

Apart from the standard size bucket of 10.5 cu. ft. capacity, there are two other sizes available. The makers can supply a heavy duty bracket of 6.5 cu. ft. or a light materials bucket of 14.5 cu. ft. for use when loading coal or coke. Interchange of buckets can be very readily effected.

Radio-controlled Fork-lift Truck

The General Electric Co. Ltd., Kingsway, London, W.C.2 announce a successful experiment at the Motor Show when a fork-lift truck made by the Owen Organisation was fitted with V.H.F. radio/telephone equipment and thus controlled by radio from a central stand at the Exhibition.

The truck was used primarily by the Owen subsidiary, Salopian Engineers Ltd., but was also at the disposal of other exhibitors. One transmitter/receiver was installed on the conveyancer, another at the control stand; the equipment on the truck operates directly off the truck batteries, no separate accumulator being required. Any exhibitor wishing to utilise the truck rang up the stand; the controller then called up the truck and gave the driver his instructions. In this way it was possible to control the truck without any difficulty over the large and complicated site. The controller was always in touch with the truck and no time was lost in sending it where it was most required.

G.E.C. claim that this system of radio-telephony will prove most useful in port operation, resulting as it does in a more efficient use of trucks over a wide area. A radio link between each truck and the traffic manager's office will enable orders to be transmitted over a twenty-mile radius. It is also claimed that this method will prove valuable as a means of communication between ships, cranes and trucks with resulting higher efficiency.

Wanted

▶ **ELEVATOR BARGE** 400 c. yd.

Write to Box No. 152, "Dock & Harbour Authority," 19, Harcourt Street, London, W.1, England.

APPOINTMENTS.

KENT RIVER BOARD.

Applications are invited for the following appointments in the Engineer's Department:

(i) ENGINEERING ASSISTANTS—Grade VI, £670 to £735.

(ii) JUNIOR ENGINEERING ASSISTANTS—Grade APT I—V, £465 to £645.

Applications for the Grade APT VI appointments should be chartered civil engineers and have had experience in the design and construction of civil engineering works, preferably in connection with land drainage and sea defences.

Applications for the Grade APT I—V appointments will be graded according to experience and should hold an engineering degree or have passed Parts A and B of the Associate Membership examination of the Institution of Civil Engineers. Opportunities exist for applicants in this Grade to serve as Assistants under Agreement to the Engineer.

National Conditions of Service apply to the appointments which are within the establishment of the Board, and, subject to medical examination, the successful candidates will be specified as contributory employees under the Local Government Superannuation Act, 1937.

Applications with the names and addresses of three referees should be forwarded to the Engineer to the Board, 78, College Road, Maidstone.

River Board House,
London Road,
Maidstone.

A. G. STIRK,
Clerk of the Board.

THE BRITISH TRANSPORT COMMISSION (DOCKS AND INLAND WATERWAYS), 22, Dorset Square, London, N.W.1, invite applications for the position of ENGINEERING ASSISTANT at the Office of the Civil Engineer, South Wales Docks (East) at Barry Docks; starting salary £775 p.a.

Applicants must have experience in design and construction of dock gates, caissons and similar structures, and shipyard experience. The person appointed will be responsible for the preparation of drawings, estimates, specifications for the construction and maintenance of dock gates and similar structures.

Preference will be given to applicants who hold a suitable Engineering Degree and/or are Members of one of the senior Engineering Institutions. Applications should be sent to the Staff and Establishment Officer at the above address to arrive not later than the 30th November, 1953.

TENDERS WANTED.

CITY OF LIVERPOOL.
RIVER MERSEY. OTTERSPOOL RIVER WALL EXTENSION.

1. Tenders are invited by the Corporation of Liverpool for the construction of a River Embankment and works in connection therewith on the River Mersey.

2. The Contract Documents, drawings and instructions as to tendering may be inspected on and after the 2nd day of November, 1953, at the offices of the City Engineer and Surveyor, Municipal Buildings, Dale Street, Liverpool, or of Messrs. Coode and Partners, 9, Victoria Street, London, S.W.1.

3. Firms desiring to tender may obtain copies of the Contract Documents between the 2nd and 28th days of November, 1953, from either the City Engineer and Surveyor in Liverpool or Messrs. Coode and Partners in London upon payment of £10 for each set of documents, returnable on receipt of a bona fide tender.

4. Tenders must be submitted to the Town Clerk, Municipal Buildings, Dale Street, Liverpool 2, and will be received up to noon on the 30th day of December, 1953, or a date to be notified later.

Municipal Buildings,
Liverpool 2.

THOMAS ALKER,
Town Clerk.

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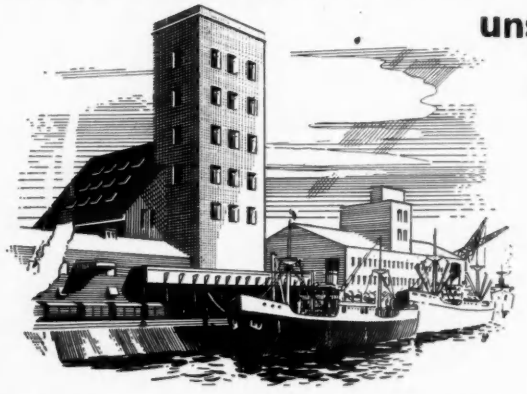

THE site selected for a Grain Elevator at Capetown was reclaimed land made up with ashes, clay, sand, rubble, town refuse and rubbish. The whole of the area was tidal with no appreciable lag. During the first excavation, water was struck at a few feet down, and no further excavation was possible, water entering the excavation as fast as it was pumped out. The average thickness of the loose material overlying the virgin rock was 19 ft. 6 in., and it was decided to construct by the cementation process a solid and watertight barrier to act as a coffer dam and enclose the area to be excavated. The total length of this coffer dam was 828 ft. The effect of this was to allow excavation to be continued in dry ground.

During the excavation the line of cutting intercepted the wrecked hull of an old wooden ship. Difficulty was experienced in removing the wreck from the excavation and the cemented coffer dam became fractured, allowing feeders up to 80,000 gallons per hour to enter. These feeders were stopped by further treatment, demonstrating beyond all doubt the effectiveness of the process.

It is of some interest to record that the cracks and even the worm holes in the exposed timber of the hulk were found filled with cement.

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